THE

FOUNDRY TRADE JOURNAL

WITH WHICH IS INCORPORATED

THE IRON AND STEEL TRADES JOURNAL.

VOL. 35. Thursday, February 3, 1927. No. 546

PUBLISHED WEEKLY.

Subscription Terms: 15s. per annum
Foreign and Colonial, 17s. 6d. per annum,
All Subscriptions are payable in advance.

All communications to be addressed to the Editor, or to the Publisher, as the case may be, of

THE FOUNDRY TRADE JOURNAL,
49, WELLINGTON STREET, LONDON, W.C.2.

Telephone: Gerrard 3951 (4 lines).
Telegraphic Address: "Zacatecas, Rand, London."

Contents.

	PAGE
Alloys or Machinery?	91
Institute of Metals	92
Correspondence	92
Chaplets for Heavy Castings	93
Drum Type Controllers and Unbreakable Resistances	95
Selection and Use of Refractory Material	97
Impact Testing of High Duty Cast Iron	98
Some Recent Discoveries of Mediæval Tools	101
Steels for Structural Purposes	102
American Foundry Practice	103
New Members for the B.C.I.R.A.	106
Trade Talk	108
Iron and Steel Markets	110

Forthcoming Events.

FEBRUARY 5.

Swansea Technical College Metallurgical Society:—Annual dinner.

FEBRUARY 9.

Institution of Welding Engineers:—Ordinary meeting at Manchester. "The Welding of Cast Iron," Paper by P. L. Roberts.

FEBRUARY 10.

Institute of Metals (London Local Section):—Joint meeting with the Electroplaters' and Depositors' Technical Society in London. "Nickel Coatings—Methods of Production," Paper by W. R. Barclay, O.B.E.

FEBRUARY 11.

Institute of Metals (Sheffield Local Section):—Ordinary meeting at Sheffield. "Bronze," Paper by R. T. Rolfe.

Institute of Metals (Swansea Local Section):—Singleton Park. "The Design of Annealing Furnaces," Paper by J. S. Caswell.

FEBRUARY 14.

Institute of Metals (Scottish Local Section):—Ordinary meeting at Glasgow. "Notes on Aluminium Alloys," Paper by D. R. Tullis.

Institute of British Foundrymen.

FEBRUARY 10.

London Branch:—Ordinary meeting in London. "The Impact Testing of High Duty Cast Iron," Paper by J. G. Pearce.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

Institute of British Foundrymen.

PRESIDENT, 1926-27: Vincent C. Faulkner, "Thalassa," Carlton Avenue, Kenton, Middlesex.

LIST OF SECRETARIES—

General Secretary: T. Makemson, Saint John Street Chambers, Deansgate, Manchester. London Office, 49, Wellington Street, London, W.C.2.
Birmingham: F. K. Neath, 16, Sarehole Road, Hall Green, Birmingham.
Sheffield: R. Village, "Bircholme," Dronfield, near Sheffield.
Scottish: J. Bell, 60, St. Enoch Square, Glasgow.
London: H. G. Sommerfield, Charterhouse Chambers, Charterhouse Square, London, E.C.1.
Newcastle-on-Tyne: Colin Gresty, 101, Queen's Road, Monkseaton, Northumberland.
East Midlands: H. Bunting, 17, Marcus Street, Derby.
West Riding of Yorkshire Branch: S. W. Wise, 110, Pullan Avenue, Eccleshill, Bradford.
Wales and Monmouth Branch: J. J. McClelland, M.I.Mech.E., Druslyn, Bishops Road, Whitechurch, Glam.
Middlesbrough: N. D. Ridsdale, 3, Wilson Street, Middlesbrough.

Welsh Engineers' and Founders' Association

Secretary: F. J. Griffiths, 20, Fisher Street, Swansea.

Foundry Trades Equipment & Supplies Association.

Secretary: K. S. Bridges, Avenue Chambers, Southampton Row, London, W.C.1.

Alloys or Machinery?

In the last issue of the "Iron Age" to reach this country there appears an erudite article written by Mr. H. P. Parrock, who outlines an avenue for the development of cast-iron foundry practice in the United States. The author states that the main improvements effected during the last 25 years have been in the intensive utilisation of moulding machines, sand handling equipment, cupola-charging devices, fettling tools, cranes and boxes—in fact, everything of a mechanical nature. He cites as a requirement for the future a large electric furnace to act as a mixer does in the matter of the conversion of iron to steel. This is to be supplemented by smaller electric furnaces for the melting of alloys, as he visualises a great improvement in the properties of cast iron by such additions. Whilst it is freely admitted that such developments are desirable, we are convinced that British progress can be best ensured by concentrating on the very factors, which Mr. Parrock assumes are *un fait accompli* in the United States. A study of Mr. Jolley's Paper, printed elsewhere in this issue, shows in the clearest possible manner that the conditions existing in the Western Hemisphere are totally different from British, and require emulation only in so far as quantity production methods are concerned. For jobbing work and quality castings there is but little difference in the methods obtaining in the two continents. We have good grounds for stating that in the near future intensive efforts will be made both by British founders and by alloy manufacturers to produce new cast irons having superior properties, and a word of warning at this juncture should not be out of place. Cast iron having roughly the same specific gravity as steel, no weight advantage can ever come about, as is the case with, say, magnesium or aluminium; but it has better teeming properties in its ordinary state. The price of steel castings is now of a modest character, and any large alloy additions would quickly place it in competition with that material. It can, and should, be worked out exactly the quantities of the various alloys which can be commercially added before reaching the price of steel castings. Another factor not to be neglected is competition which malleable cast iron can bring to bear against any "improved" cast iron where the improvement has been effected by alloy additions. The trend of modern thought is centred around the production of a cast iron with its carbon in the "temper" condition direct from the cupola or other cheap melting medium, and if the introduction of a small quantity of some alloy can accomplish this then true progress will have been made, as a certain amount, say a maximum of 5 per cent., of elongation can be expected. After this, forgeable and stainless material can be sought, though the latter is unlikely to be of the chromium type, the Invar base being the more probable.

It is essential that British founders should follow closely every phase of foreign research and development of the foreign product. This is apparently a Governmental activity in the United States. During recent years French foundries have been exporting considerable quantities of cast iron pipes to the American Eastern seaboard, and these have been the subject of a comparative research, using also domestically-produced material by the United States Bureau of Standards. This is a phase of activity which could be usefully and extensively imitated by Great Britain, as when the properties of competing material are thoroughly understood the question of meeting it becomes so much easier.

The Institute of Metals.

Annual General Meeting.

As previously announced, the annual general meeting will be held, by kind permission, in the Hall of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.1, on March 9 and 10, 1927.

On March 9 the annual dinner of the Institute will be held at the Trocadero Restaurant, Piccadilly Circus, W.1, at 7 p.m. The dinner, at which there will be a shortened toast list, will be followed by a dance, ending at midnight. It is hoped that many ladies will be present, in order that the Institute's first dance in London may be a complete success.

PROGRAMME.

Wednesday, March 9.

10 a.m.—12.30 p.m.—GENERAL MEETING in the Hall of the Institution of Mechanical Engineers.

The Report of Council and the Report of the Honorary Treasurer will be presented.

The result of the Ballot for the election of the Council for 1927-8 will be declared.

The President will read his Presidential Address.

Papers Nos. 418, 419 together, and (416) will be presented and discussed.

2 p.m.—4 p.m.—Paper No. 427 will be presented, and a general discussion on "Electric Furnaces in Non-Ferrous Metallurgy" will follow.

6.45 p.m. for 7 p.m.—ANNUAL DINNER AND DANCE at the Trocadero Restaurant, Piccadilly Circus, W.1.

Thursday, March 10.

10 a.m.—12.30 p.m.—The adjourned meeting will be resumed. Papers Nos. 430, 425, 431 (together), 424, (421, 422) will be presented and discussed.

2 p.m.—4 p.m.—Papers Nos. 417, 428, 423 (415, 429, 420, 426) will be presented and discussed. The meeting will be brought to a conclusion.

Papers.

The following Papers are expected to be submitted:—

Serial No.

415.—"Magnetic Analysis as a Means of Studying the Structure of Non-Magnetic Alloys," by Professor Kôtaro Honda and Professor Hikozo Endo.

416.—"Brittleness in Arsenical Copper," by Clement Blazey.

417.—"The Influence of Calcium on Aluminium Containing Silicon," by J. D. Grogan. With an Appendix on "The Estimation of Calcium in Aluminium Alloys," by P. G. Ward.

418.—"Investigation of the Effects of Impurities on Copper. Part V.—The Effect of Bismuth on Copper," by Professor D. Hanson and Grace W. Ford.

419.—"Investigation of the Effects of Impurities on Copper. Part III.—The Effect of Arsenic on Copper. Part IV.—The Effect of Arsenic plus Oxygen on Copper," by Professor D. Hanson and C. B. Marryat.

420.—"Examination of a Fifteenth Century Brass," by J. Newton Friend and W. E. Thorneycroft.

421.—"The Application of Strain Methods to the Investigation of the Structure of Eutectic Alloys," by F. Hargreaves.

422.—"Note on the Crystallisation of the Lead-Tin Eutectic," by F. Hargreaves.

423.—"The Mechanism of Inverse Segregation in Alloys," by R. Genders. With an Appendix on "The Accurate Determination of Copper in Bronze by Electrolysis," by R. A. F. Hammond.

424.—"Notes on the Manufacture and Properties of Hair Springs," by H. Moore and S. Beckinsale.

425.—"The Penetration of Brass by Tin and Solder, with a Few Notes on the Copper-Tin Equilibrium Diagram," by J. H. Miller.

426.—"Note on the Silver Contents of Roman Lead from Folkestone and Richboro' Castle," by J. Newton Friend and W. F. Thorneycroft.

427.—"Electric Furnaces in Non-Ferrous Metallurgy," by D. F. Campbell.

428.—"The Magnesium-Rich Magnesium-Copper Alloys," by Max Hansen.

429.—"An Etching Reagent for Copper," by Professor Bernard W. Holman.

430.—"The Penetration of Mild Steel by Brazing Solder and Other Metals," by R. Genders.

431.—"The Attack of Molten Metals on Certain Non-Ferrous Metals and Alloys," by Harold J. Hartley.

Autumn Meeting.

The Council have pleasure in announcing that the annual autumn meeting will be held in Derby from September 6 to 9, 1927. It is hoped that this early notification will enable many members to arrange to attend the Derby meeting.

The plans for the meeting are being made under the kind direction of Sir Henry Fowler, K.B.E., LL.D., Vice-President, of Derby.

Papers for this meeting should be received by the Secretary not later than April 30, 1927.

New Members.

A great effort is being made to bring the membership of the Institute to over 2,000 by the end of the present year. A Special Council Meeting will be held in London on February 23 for the purpose of considering applications for membership. Those applicants for membership whose forms are in the Secretary's hands before noon on February 23 will be entitled to take part in all the proceedings at the London meeting. Subscriptions of members elected as a result of the forthcoming election cover the extended period ending June 30, 1928. Further, they will be entitled to receive a free copy of the Journal that is to be published in June at 31s. 6d. (price to non-members), in addition to (free) volumes to be published at the same price in December, 1927, and June, 1928. It is hoped that this concession will lead to a considerable increase of new members and students during the ensuing half-year. Members are asked to make this arrangement known to persons suitable for membership of the Institute. The necessary membership forms and booklets will be sent upon application to the Secretary, at 36, Victoria Street, London, S.W.1.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

To the Editor FOUNDRY TRADES JOURNAL.

Fluorspar in Cupola Practice.

SIR,—I am interested in the article in your issue of the 20th inst., on the "Use of Fluorspar in Cupola Practice."

There appears from time to time papers from Continental sources in which considerable amount of detail work has been done, claiming advantage for the use of fluorspar.

Other than in basic open-hearth work, I fail to find such results to be substantiated in British or American practice. Why is this? I recently wrote to a considerable number of metallurgists in this country and to several well-known Americans, and so far as cupola work is concerned, in practically all cases the reply was "they found practically no advantage in its use."

I am not acquainted with any published British research on this question, nor yet have I any information where figures are given to substantiate the British experience.

Perhaps, Sir, the wide range of your readers may be able further to enlighten me as to the extent of the use of fluorspar in foundry work and what conclusions they have formed particularly as to—

1. Working effect in cupola, as to speed of melting and metallic loss.
2. The effect on the lining.

Thanking you in anticipation

I am yours, etc.,

Sheffield, Jan. 5. A. C. DALTON.

MR. THOMAS COOPER NEVILLE, of Westbourne Road, Walsall, engineer and ironfounder, who died on December 4, left estate of the gross value of £22,703, with net personalty of £18,651.

Chaplets for Heavy Castings.*

By Ivan Lamoreux, Liège, Belgium.†

The use of chaplets in moulding heavy castings gives rise to numerous accidents which it is very difficult completely to avoid. By examining the reactions of the chaplets during casting, instructions for the founder will be indicated. Chaplets must be capable of standing up to the crushing stresses due to the upward thrust exerted by the metal by virtue of Archimedes' principle.

It would be a very simple matter to calculate these stresses if they were purely normal, but their strength. If the chaplet is made of mild steel it will bend, and if of cast iron it will crack.

Welding of chaplets has been frequently mentioned; but it is hardly possible, in the writer's opinion, actually to weld iron (mild steel) to cast iron, at least in large masses. A perfectly sound and close contact may be obtained, provided that an iron be used which is sufficiently liquid to give a sound casting but not too hot to prevent

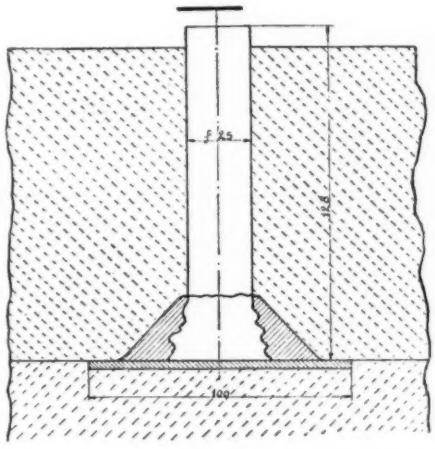


FIG. 1.—SHOWING CRACKING OR DISPLACEMENT OF CHAPLET.

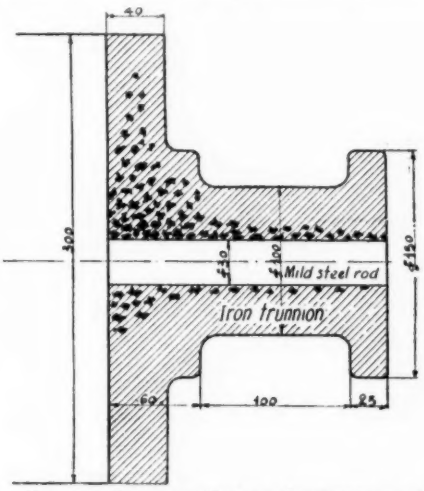


FIG. 2.—SHOWING POROUS CONDITION OF A CASTING WHEN STEEL RODS ARE USED FOR REINFORCEMENT.

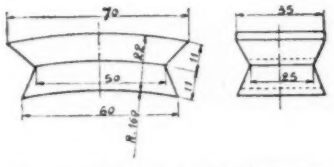


FIG. 3.—DESIGN OF C.I. SUPPORTS WHICH GAVE TROUBLE BY CRACKING. DIMENSIONS IN MM.

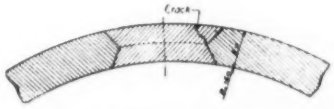


FIG. 4.—SHOWING CRACKING OF CAST-IRON STUDS IN THE DESIGN SHOWN IN FIG. 3.

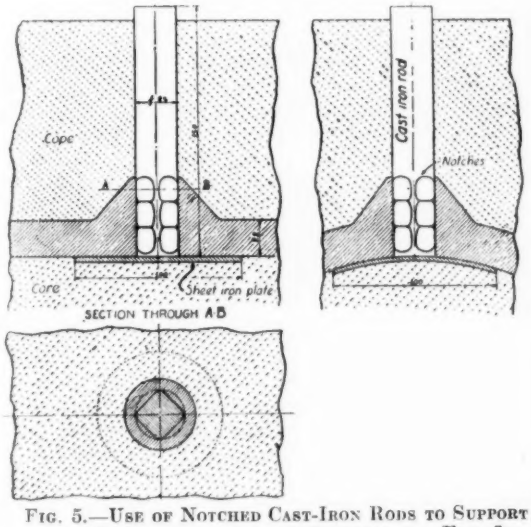


FIG. 5.—USE OF NOTCHED CAST-IRON RODS TO SUPPORT CORE, SUPPLANTING THOSE SHOWN IN FIG. 3.

the pressure is nearly always exerted under very unfavourable conditions, for the high temperature of the molten metal surrounds the chaplet, and, by gradually heating it, weakens its powers of resistance.

In addition, it sometimes happens that metal leaks through the joints of the flask or at the core prints, and, in order not to lose the casting, pouring is continued until the leak stops. During this time, the inflow of hot iron reaches the chaplets placed in the passage situated between the gate and the riser, and so greatly jeopardises the reactions taking place. It has been found that mild steel, immersed in cast iron, sets up reactions.

Certain founders, when they cast large boxes, hit upon the idea of strengthening the trunnions by means of a mild-steel rod placed inside them (see Fig. 2). As the metal must be very hot to enter the mould cavities before solidifying, it causes bubbling around the steel rod, resulting in a porous region. If, despite this porosity, the mild-steel rod remains intact in the casting, the trunnion probably remains fairly sound, but, owing to its close contact with the carburised metal, it absorbs part of the carbon, and, since cooling is rather slow, the mild-steel rod is car-

D

* Paper submitted on behalf of the Belgian Foundrymen's Association to the American Foundrymen's Association.

† First Vice-President of the Belgian Foundrymen's Association.

burised and rendered brittle.* The object sought is thus negatived.

The same thing is true of strengthening pieces formed by a cast-iron slab in which mild-steel lugs are incorporated. If this reinforcement is subjected to a lateral stress, there is a danger of the lugs being sheared clean off at the slab. Where breakage does occur in this way, the fracture is found to be bright and crystalline, and not dull and fibrous, which was the appearance of the steel before being embedded in the cast iron. Some examples taken from current practice will show the dangers likely to arise and the solutions suggested by experience.

Pipes for Chemical Plants.—A foundry had cast a set of 48 U-shape pipes about 8 ft. long, 12½ in. diameter, and 0.85 in. gauge. These pipes had to stand up to hot gases under pressure, and consequently had to be free from any suspicion of porosity, etc. Curved cast double-ended chaplets had been used as shown in Fig. 3. When the pipes were tested, leaks were found where the chaplets had been, and abortive attempts were made to eliminate them. Upon sawing through a chaplet, it was found that the shrinkage of the pipe casting had caused the chaplet to come away forcibly, and the sharp edges of the casting had compressed the chaplet as in a pair of shears (see Fig. 4).

To overcome this trouble, definitely clean cast-iron rods were taken and notched as in Fig. 5, then the chaplet, covered with sand, was rested on a sheet-iron plate embedded in the core, then secured at the top by the ordinary methods.

During casting, the iron having escaped through this connection, pouring had to be continued for some minutes to keep the mould full. Owing to the high temperature set up by the flow of the cast iron, the chaplet buckled and the core rose to the top, thus rendering the casting useless.

The solution was found by using a cast-iron rod, 2 in. in dia. with a 6-mm. (¼-in.) V-thread, as shown in Fig. 6. If it happens that the iron is slightly cold and a leak is discovered at the region of the threaded rod, it is removed by unscrewing, and another mild-steel rod of slightly greater diameter is inserted in the tapped hole. Thus if a casting is rendered useless by the ordinary chaplets, it can quickly be rendered serviceable at small cost.

Lathe Bed.—In casting a 25-ton lathe bed about 39 ft. 3 in. long and of the section shown in Fig. 7, it was decided to support the cores by strong studs, because of the great distance the metal had to flow and the position of the gate at the end of the slides.

As a precaution, cast-iron studs were used as shown in Fig. 8, and, at the moment of filling, the iron, having to travel a considerable distance, rose slowly and lingered between the chaplets placed under the cores. The result was that the metal cooled quickly with a fine grain and shrunk considerably. The slow cooling of the slides set up a stress in the part where the chaplets were, and, when the casting was stripped, it broke along the lines shown (Fig. 7).

This casting was finally turned out by using mild-steel chaplets formed of two sheet-iron plates joined by a cross-piece, the mass of which only slightly affected the temperature of the metal and its flow in the mould.

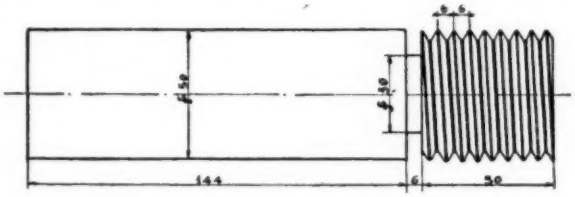


FIG. 6.—THREADED CAST-IRON ROD. DIMENSIONS IN MM.

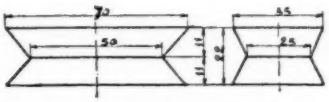


FIG. 8.—DESIGN OF CHAPLET USED TO SUPPORT CORES OF LATHE BED (FIG. 7). THEY WERE REPLACED BY SHEET-IRON PLATES.

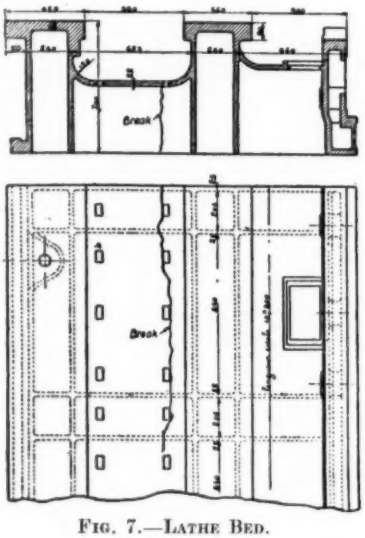


FIG. 7.—LATHE BED.

* McWilliam and Arnold's experiments.

Conclusions.

Dimensions.—The proportions between the dimensions of the chaplets and those of the casting should be fixed so as to effect a compromise between the strength of the chaplet when it is supported by cast iron and to prevent fracture of the casting upon cooling.

Shape.—In castings subjected to hydraulic or other pressure, use threaded chaplets that permit soundness to be obtained. In other castings, use the less expensive stud chaplets.

Welding of Chaplets.—It is useless and dangerous to try to weld the chaplets, which cannot be joined except by considerably altering the composition of the metal.

Company Reports.

William Asquith (1920), Limited.—Interim dividend on preference shares passed.

Warner & Company, Limited.—Interim dividend, 2½ per cent. on ordinary shares.

Consett Spanish Ore Company, Limited.—Interim dividend, 1s. 6d. per share, less tax.

Herbert Morris, Limited.—Dividend for half-year on 6 per cent. (less tax) and 5 per cent. (free of tax) cumulative preference shares.

John Shaw & Sons, Wolverhampton, Limited.—Net profit, £4,484; amount brought forward, £42,192; total, £46,676; dividend, 3 per cent., less tax, on ordinary; carried forward, £38,575.

Obituary.

MR. C. Y. MITCHELL, head of the firm of C. Mitchell & Sons, Limited, engineers, at Heaton, Bolton, died recently, aged 56.

MR. THOMAS ERSKINE, who about fifteen years ago became a partner in the firm of Walter Macfarlane & Company, Saracen Foundry, Glasgow, died last week in the Glasgow Western Infirmary, as the result of injuries which he received on January 14 through being knocked down by a motor. Mr. Erskine, who was 70 years of age, had been associated with the firm for many years.

Drum Type Controllers and Unbreakable Resistances.

With the object of affording the utmost reliability and convenience from an installation and maintenance viewpoint, the British Thomson-Houston Co., Ltd., Rugby, has developed an entirely new line of reversing drum controllers for use with electric motors operating industrial equipments, such as foundry cranes, cupola hoists, and the like.

Drum Type Controllers

These controllers differ entirely in construction from those hitherto manufactured, and incorporate many special features based on the long and extensive experience which this company has enjoyed in connection with the electrical driving of cranes, foundry auxiliaries and other plant, where the operating conditions are of the most arduous nature. This range of B.T.-H. controllers meets the requirements for A.C. slip-ring induction motors up to 75 h.p. 550 volts, and D.C. motors up to 120 h.p. 550 volts.

As the same features are common to both types of controllers, the design can best be described by reference to one type, for example, a D.C. controller.

The frame consists of separate top and bottom castings fixed together by means of square section steel bars: the back and front covers are of sheet iron and both are detachable. The side projections on the back cover are so small that they do not prevent easy access to any working part, so that when the front cover is removed, by the release of four spring catches, the whole of the inside of the controller is accessible. A.D.C. controller with front cover removed is shown in Fig. 1. The back cover being separate from the

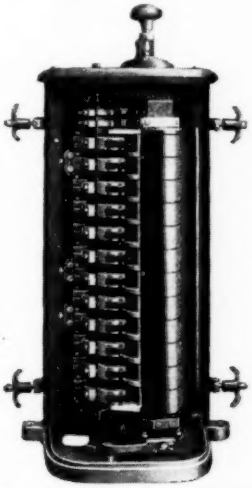


FIG. 1.—NEW TYPE B.T.-H. DRUM CONTROLLER FOR D.C. CIRCUITS. FRONT COVER REMOVED.

frame, it can be removed for such operations as drilling for conduit connections.

The body of the drum consists of ribbed castings carrying the copper contact segments with their renewable arcing tips, and all the segments are of the same diameter. The starwheel, which is securely fixed to the top of the cylinder, is designed to give positive notching at each starting point, and the pawl is fitted with a large roller and roller pin to obtain a maximum wearing surface. The pawl spring is in compression, and is quite accessible and easily removed.

All the contact fingers are built up from heavy extruded sections: the fixed part, or finger base, is clamped on four sides of a mica-insulated square steel bar, and the moving part is attached to the fixed part by a pivot screw of large diameter, and ample wearing surface. A heavy section renewable tip is fitted, and adjustment of the tip in relation to the segments on the cylinder is effected by means of a screw which operates on an extension of the finger arm. This screw is adjustable to one-sixth of a turn and is automatically locked in position. The arrangements are shown in Fig. 2, which illustrates a medium-sized pivoted contact finger. Pressure of the finger on the segment is obtained by means of a compression spring, which is free to function without friction on any part of the finger. The pivot is not used for carrying current, a flexible shunt being fitted between the moving and the

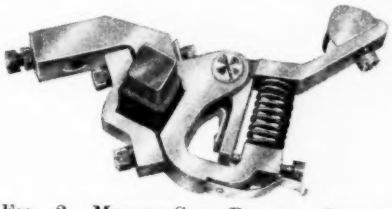


FIG. 2.—MEDIUM-SIZE PIVOTED CONTACT FINGER. (THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED.)

fixed part. As the shunt is entirely enclosed it cannot become accidentally damaged.

The finger bar is mounted towards the front of the controller, and the screws for fixing the fingers to the insulated bar are accessible from the front or side; any finger can be removed from the bar in a simple manner without disturbing the remainder or taking out the whole bar. The process consists solely in taking out the cable and removing the two screws which fix the finger to the bar.

Interlocking fingers are provided so that an electrical interlock exists between the controller and a protective circuit breaker, whereby, should the circuit breaker trip, it cannot be reset unless the controller is in the "off" position. These interlocking fingers, and also those used in conjunction with shunt limit switches, are of robust design, and are mounted at the top of the controller on the main finger bar. Although smaller, these fingers are of the same type as the main fingers, and as the interlock segments are of the same diameter as the main segments, the drum can be withdrawn after removal of the cap plate, without fouling the interlocking fingers.

Fire-proof arc deflectors are provided between the contacts so as to prevent cross arcing. The portion of the deflector which acts as a barrier between each finger is moulded in one piece with the portion which is shaped to slip over and enclose the pole piece of the magnetic blow-out. The construction of these barriers is, therefore, very strong; screws are not used for fixing, and there is no possibility of the barriers working loose. In order to facilitate inspection and cleaning the assembled arc deflector is hinged so as to swing clear of the fingers: Fig. 3, showing

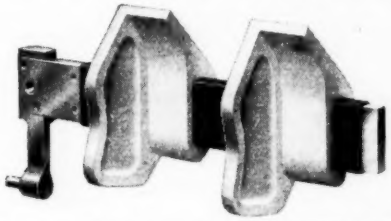


FIG. 3.—PORTION OF ARC DEFLECTOR BAR FOR B.T.-H. CONTROLLERS, SHOWING DESIGN AND METHOD OF MOUNTING MOULDED ARC DEFLECTORS.

a portion of the bar, indicates the shape of the moulded arc deflectors and how each is threaded on to the bar.

A new type of crank handle with an automatic "off" position latch is fitted as standard. In the opinion of many users the function of a latch in the "off" position is to prevent the handle from being accidentally knocked into a running position, while the latch mechanism should not be irksome to the operator when the

controller is in use. In this design of controller there is no external projection to the wooden knob on the handle, the knob being of big diameter and having a smooth rounded top; the latch mechanism is released from below the casting which forms the handle by the weight of the operator's hand on the top of the knob.

Controllers for A.C. duty are of similar design, as may be seen by reference to Fig. 4, which

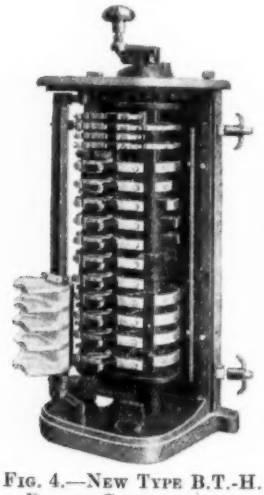


FIG. 4.—NEW TYPE B.T.-H. DRUM CONTROLLER FOR A.C. CIRCUITS. FRONT COVER REMOVED AND ARC DEFLECTORS OPENED.

shows a typical A.C. controller with cover removed and arc deflectors opened. Four arc deflectors only are required in this design, as cross arcing can only take place between the fingers in the stator circuits.

All the controllers can be fitted, if desired, with lever mechanism having either a vertical or horizontal "off" position; alternatively, a rope-wheel can be fitted in the smaller sizes, and a spring return mechanism can also be fitted.

The space allowed for cables in these controllers is approximately five times as large as that hitherto provided, this large cable space being obtained by the arrangement of the finger bar towards the front of the controller. If desirable in any instance, cables of the same size can be used for the incoming leads, and motor and resistance connections. Except in the largest size, which has sweating sockets and clamping screws, all terminals are fitted with pinching screws, double terminals being provided in those cases where it is necessary to run two cables to one finger.

A large aperture, which can be fitted with a plate drilled for conduit, is provided in the bottom of the controller so that all the cables can be brought in together. Armour clamps or sealing boxes can be fitted to the back cover, and by means of standard cable fittings various methods of connection can be adopted.

Unbreakable Resistances.

For use with the drum-type controllers described, as well as with other forms of control gear, the British Thomson-Houston Company has recently perfected manufacturing equipment for a new type of light, unbreakable resistances in which the grids are so graded that the appreciable temperature-resistance coefficient usually associated with all unbreakable resistances does not adversely affect the electric motors or equipment with which they are used. If specially required, grids can be supplied with practically a zero temperature-resistance coefficient.

The resistance element is composed of a continuous length of resistance strip, machined-formed into grids, and in the complete resistance section there are no joints between the two external terminals. A typical unbreakable resistance

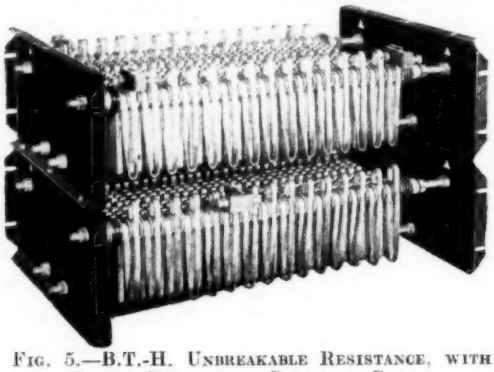


FIG. 5.—B.T.-H. UNBREAKABLE RESISTANCE, WITH COVERS REMOVED TO SHOW THE GRIDS.

of this type, with covers removed to show the grids, is illustrated in Fig. 5. High-resistance steel strip, heavily plated with zinc to render it rustless, is generally used, but in some cases another rustless material may be used for the smaller sizes.

Resistances can be supplied in any of the combinations already adopted for cast grids: for crane service each bank is mounted in a separate box, consisting of two pressed steel end-frames which are so flanged that any number of boxes up to six may be bolted together to form a self-contained unit. The grids are supported between the end-frames by four mica-insulated steel bolts, adjacent grids being insulated from one another by mica washers between steel washers. This construction is such as to prevent the grids touching, even under the most severe operating conditions. Another notable feature is the method adopted for mounting the terminals so as to ensure not only good contact between terminal and resistance, but also rigid support for the incoming cable: the terminals are of extruded brass section and are bolted to a loop in the grid immediately above one of the insulated bolts for all units up to approximately 200 amperes at 5-minute rating.

Application.

In the accompanying illustration, Fig. 6, are shown the complete connections for a typical

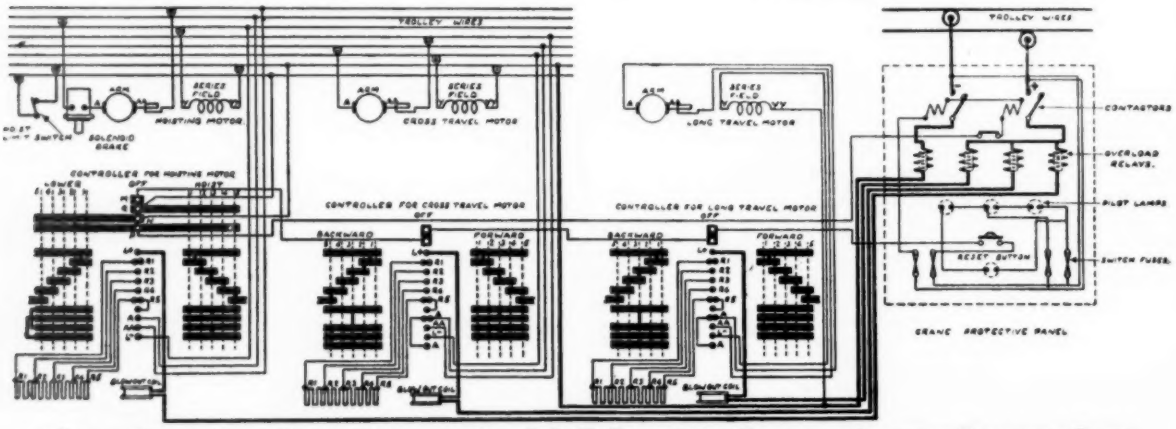


FIG. 6.—TYPICAL CRANE CONNECTON DIAGRAM FOR B.T.-H. THREE-MOTOR EQUIPMENT, INCLUDING PROTECTIVE PANEL, SERIES SOLENOID BRAKE, AND LIMIT SWITCH ON HOISTING MOTION.

B.T.-H. travelling gantry crane installation with three direct-current motors, protective panel, series solenoid brake, and limit switch on the hoisting motion. The illustration is self-explanatory and the simplicity of the wiring will be noted.

The main incoming supply is taken from the trolley wires direct to single-pole, contactor-type circuit breakers fitted with low-voltage releases. Connected to the circuit breaker on the positive side is a busbar from which emanate the main cables feeding the controllers and motors for the hoist, traverse, and travel motions, respectively: immediately after leaving this busbar the current in each case passes through a separate adjustable, magnetic, overload relay fitted with time-lag device, and returns to the negative trolley wire from either of the three controllers and motors, via a common cable leading to a fourth overload relay on the crane panel and the negative line contactor. Thus, all motors and controller circuits are fully protected against serious overloads on both the positive and negative sides.

The scheme of electrical interlocks between each controller and the appropriate circuit breaker is the scheme which was patented by the British Thomson-Houston Company many years ago and is now very extensively adopted. It ensures that when the circuit breaker is closed, an operator, however unskilled, cannot leave a motor connected to any live part of its controller with the resistances entirely or partially cut out. Conversely, it is impossible to close the circuit breaker unless the controller is on the "off" position.

Should the contactor-type circuit breakers trip out through an overload occurring on any motor, all that is necessary is for the operator to return each controller handle to the "off" position and press the re-set button provided, when the circuit breakers will automatically close, and make their own retaining circuits, thereby permitting the controllers to be moved from the "off" position so as to restart the motors.

The pilot-control circuits and pilot lamps, for which provision is made on the crane-protective panel, are protected by switches and fuses, and a portable hand lamp on flexible cable may be plugged into the panel.

Selection and Use of Refractory Material.

A meeting of the Co-ordinating Committee, comprising the Staffordshire Iron and Steel Institute, the local Section of the Institute of Metals, and the Birmingham Metallurgical Society, was held at the Engineers' Club, Birmingham, on Thursday, Mr. Edgar M. Boote in the chair.

In the unavoidable absence of Dr. Fearnsides, MR. W. J. REES, B.Sc., F.I.C., presented a Paper on "Selection and Use of Refractory Materials." He remarked that for a good many years he had observed refractories in use in many different types of industrial furnaces, and, as a result, he could roughly classify the failures, or frequently so-called failures, of the refractories into four classes. The first was the unsatisfactory quality, or possibly lack of uniformity, of the material. Secondly, failures through faulty selection due primarily, he was afraid, to the user's lack of knowledge of the conditions which the material had to meet. The third class of failure was due entirely to faulty treatment of the material. The fourth class—perhaps the minor class of failures—was due to the lack of a margin of safety. In some types of furnace there were admirable conditions existing theoretically, but at times the material had not been chosen with a sufficient factor of safety. Nearly all the failures one met could be classified in that way. He had been surprised from year to year by the comparatively small number of failures which were due to the unsatisfactory quality of the materials supplied by the particular makers. A great many failures were due to causes other than the supply of really unsatisfactory material.

The durability of refractories in industrial furnaces depended upon a few conditions, the most important of which were: (1) The softening temperature, frequently referred to as the normal refractoriness or normal refractoribility; (2) the mechanical strength at normal and at high temperatures—at high temperatures that was quite commonly referred to as refractoriness under load; (3) the thermal or reversible expansion, those which were temporary expansions; and (4) the permanent expansion or permanent contraction, resistance to abrasion, resistance to slag attack, resistance to abrupt temperature changes or spalling resistance. A factor of considerable importance was the change which took place in the material—a change in its property—after long heating, and, lastly (a factor of importance in certain types of furnace, particularly blast furnaces), permeability—that went on at high temperatures.

So far as the silica composition of silica bricks was concerned, it could be said that the silica content should not be lower than 94 per cent., that the lime content should not be higher than 2 per per cent., that the content of alkalis should in no case exceed 1 per cent. At one time, importance was attached to the freedom, or comparative freedom, from iron oxide in silica bricks, but not so much importance was attached to it now. In fact, there was evidence to show that the presence of some iron oxides was definitely beneficial to the silica brick.

The author gave details of various experiments carried out some years ago with batches of silica bricks from the same kiln which had received exactly the same treatment. He found that a marked change in mechanical strength occurred after exposure to the weather. In the case of coarse-texture bricks, the mechanical strength fell to nearly half; in fine-texture bricks there was a very large decrease. The spalling tendency of the brick also increased very considerably. It was most difficult to heat up satisfactorily those bricks which had been exposed to the weather.

It was not realised as well as it might be that the load which was frequently applied to bricks in industrial practice was an important factor—the load due to the superincumbent weight of the furnace, or to the pressure of liquid, or more often to the thermal expansion of the brick. Loads of 20 to 30 cwts. per sq. in. were quite commonly reached in various parts of industrial furnaces, and it seemed a matter of extreme importance that the user should have adequate information as to the properties of the bricks he used in those particular situations in the furnace. With regard to firebricks, it was important that they should contain very little iron oxide. Some types of firebricks contained 3 or 4 per cent. of iron oxide, or sometimes a little more, and under reducing conditions that iron oxide brought about a very decided reduction in the refractoriness under load of that brick. Some rather interesting work was carried out last year by an American worker, who designed a special furnace with which to heat bricks under load in a controlled atmosphere, and he showed quite definitely that the iron-oxide content in the bricks had a marked effect in reducing refractoriness under load.

With regard to sillimanite, Mr. Rees said it was now being used for many purposes on account of its high refractoriness. Sillimanite had been found in India, but it had not been possible to make it artificially. Geologists would like to know the precise conditions of temperature and pressure which resulted in sillimanite and in mullite, between which it was difficult to distinguish. That was a work which would yield results of very considerable importance to both makers and users of refractory materials. Although very able metallurgists found it difficult to detect the difference between pure mullite and sillimanite, they could be easily distinguished by X-ray analysis. Sillimanite had given very satisfactory results in glass-melting furnaces, not only because of refractoriness, but on account of resistance offered to attack by the molten glass. Excellent results had been obtained also in other types of high-temperature furnace. It was one of the most promising materials that had been brought before them in recent years.

Replying to the discussion, MR. REES said the addition of 10 per cent. of sillimanite to fireclay very slightly increased the refractoriness under load, but the increase was not worth the cost of the addition. It was not until one got up to admixtures of 50 per cent. and upwards that they became worth while. That amount did give exceedingly valuable results. There was no difficulty in procuring normal quantities of sillimanite.

Impact Testing of High Duty Cast Iron.

At a meeting of the London Branch held at the Engineers' Club on January 13, 1927, the Branch-President (Mr. R. J. Shaw) in the chair, Mr. J. G. Pearce (Director of the British Cast Iron Research Association) presented a Paper on "The Impact Testing of High Duty Cast Iron." This paper should have been read at the February meeting of the Branch, and owing to the fact that it was read a month earlier than was anticipated, Mr. Pearce was unable to include in it the results of tests he had intended to incorporate, but which were not completed. He intimated, however, that he would deal with the subject more fully at some subsequent meeting.

The BRANCH-PRESIDENT, introducing Mr. Pearce, said the question of testing was one which founders would have to take a great deal more notice of than they had done. In the past they had been accustomed to satisfy themselves with an ordinary transverse test, but in the future they would have to do more than that.

Standard Tests.

MR. PEARCE, in the first place, discussed the transverse and tensile tests for cast iron, and said that there was a fairly well understood relationship between the tensile strength of the metal and the modulus of rupture which was obtained from the results of the transverse test. He supposed that no foundryman, if left to himself, would ever use the tensile test: it had many disadvantages, and many founders distrusted it. They used it, however, because engineers were accustomed to the tensile test in their experience with steel, and, therefore, specified it for cast iron. In the projected specifications of the British Engineering Standards Association there were included tensile and transverse tests. The Brinell test was used frequently on cast iron, but it was of extremely doubtful value on account of the lack of homogeneity of the metal. It did form a means of comparison, however, if one recognised the limitations of the test when applied generally.

It had been assumed that cast iron was entirely brittle, and had no elongation: thus, in the eyes of engineers, the tensile strength had become the criterion of the strength of the metal. The high-duty irons which had been produced in the last few years, in which the quantity of steel scrap and cast iron scrap was increasing, frequently gave a tensile strength of from 19 to 21 tons per sq. in. He suggested, however, that in many cases these high figures were obtained at the expense of the little elongation that good cast iron possessed, and that an ultra high-tensile iron was frequently extremely brittle. The service requirements of these high-duty irons for engineering purposes called for that little bit of ductility which a good cast iron possessed, and it was worth getting at the expense of some of the tensile strength.

Dealing with the question of whether a test could be employed which was free from the defects of the simple tensile or the simple transverse test, Mr. Pearce discussed the Wohler fatigue test — in which a round bar was held horizontally by one end in a lathe chuck and rotated, a load being suspended at the other end —and the Izod impact test. He concluded that something between the sudden shock, single blow, test and the Wohler fatigue test was required.

A number of slides were shown to illustrate cast-iron structures, and the effects of the varying quantity and distribution of the different constituents, and Mr. Pearce expressed the view that the impact test was one calculated to reveal the quality of the high duty cast iron provided the notch in the test bar was not a sharp one. The V notch, if it came to a point on a graphite flake or a piece of other brittle constituent, would render the bar liable to fracture very quickly, but if the collar were carefully rounded and machined evenly he believed the conditions were as good as they could reasonably be got. The impact test would seek out the ability of a metal to withstand shock, and from that point of view it worked in line with the requirements of a high-quality iron, which requirements were a diminished phosphorus content, a low total-carbon content, and as high a combined carbon content as was consistent with machineability.

He then described a commercial impact-testing machine which was being used by the Cast Iron Research Association for the testing of these irons. The test consisted of dropping a hammer of known weight from a known height, the hammer being operated by means of a cam. The test bar was about $\frac{5}{8}$-in. dia., with a groove in the centre. It was fitted into the machine horizontally, and rotated, being shaped at each end to ensure its being held properly and its rotation controlled. The average number of blows was from 60 to 90 per minute, and between each blow the bar was turned round through 180 deg., so that no two blows fell on the same spot. The number of blows required to break a bar was recorded automatically. There were two heights from which the hammer could be made to fall, and there were two hammers, each of different weight. In addition, an extra weight could be added to one hammer if desired, so that there were five different intensities of blow to suit the particular metal being tested. There was also an approximate means of converting the figures obtained by using one type of hammer into the figures that would be obtained with another type, so that comparisons could be made.

A number of results of tests on various irons were then given, the figures being the averages of a number of tests on similar irons in each case. In some cases there was a wide variation in the number of blows needed to break test bars made under exactly the same conditions and of the same composition, pointing to internal strain and lack of homogeneity.

Mr. Pearce did not suggest that the test had been worked out to anything like completion, but it seemed to him that for irons for special purposes, and particularly for the so-called high-duty irons, it did give a means of discriminating between them. Each blow to which the metal was subjected was well within the elastic limit of the metal, and the blows were repeated until fracture occurred. The test showed up differences in graphite size and distribution, differences in phosphide size and distribution, differences in moulding conditions, and so on, and it enabled one to pick out the plant and composition best calculated to give the qualities desired. He did not claim that the results of the test would enable one to say whether an iron was good or bad, but, on the evidence so far obtained, it showed that an iron which behaved well under this test was likely to behave well under service conditions. But it had to go further than that. The principle of the machine was not new, but it had not been applied previously to cast iron.

DISCUSSION.

Ideal Routine Machine Yet Undiscovered.

MR. J. W. GARDOM said that the test described was really a mixture of all the existing tests, and he had been impressed by the wide variation in the results recorded. The results given were the averages of a number of tests in each case: in one case the average of five tests showed that 900 blows were required to break the bars, but one of those bars was not broken until more than 1,700 blows had been delivered, which showed that there was a very wide variation in the results obtained with, practically speaking, the same metal. It seemed, therefore, that, as in the case of steels, there was a very pronounced difference through heat treatment. That heat treatment occurred in the grey irons during cooling, or in any composition which varied in rate of cooling. It appeared that the test described was merely an elaborate laboratory test for anything that had failed, and that it did not provide a founder with means whereby he could make a test bar, test it, and satisfy himself as to the results of the day's work. Therefore, he did not think the test described went much farther than any other test. He himself had been keen on impact and fatigue tests, but only because the conditions

represented the conditions which the metal had to stand up to in service. The metal was never subjected to transverse or tensile stresses simply, but to a combination of stresses. In the test Mr. Pearce had described we were getting towards that.

Machine Indicating Elasticity Sought.

MR. V. C. FAULKNER (President of the Institute) said that the lecture was different from, and better than, any he had yet heard from a representative of the British Cast Iron Research Association, because this was the first occasion on which he had heard a representative of the Association refer to "jobs which had come into their own shop." Up to now the work put forward by the Association had been largely the work of post-graduate students or laboratory research staffs, but now they were able to speak rather glibly of things which were sent in by members of the Association, and that was very pleasing, because it showed that they were becoming part and parcel of the industry. He had been very pleased also to hear Mr. Pearce emphasise the value of elasticity in cast iron, but was sorry that no assurance had been given that the impact test showed up any trace of elasticity. In his own view, the test which would last for cast iron was one which would quite definitely indicate elasticity. He asked Mr. Pearce whether he had found any variation in the results obtained with the machine as the result of varying the speed, because he understood that if one worked any impact machine very slowly one would get figures more like the tensile than if one worked it quickly. Some time ago the French had put forward a machine—the Frémont—wherein the test-piece was trepanned from a section of the casting. That meant, of course, that the test-piece was very small, and he asked the lecturer whether he would condemn the machine on the ground of the smallness of the test-piece. Continuing, Mr. Faulkner recalled that Professor Arnold always insisted that the Wöhler test was simply a reflection of the elastic-limit, and he did not think that that had been disproved. If one took a series of Wöhler tests and plotted a curve from them, and then took the yield point, he believed it would be found that one was a reflection of the other.

The statement made by Mr. Pearce that if the bottom of the V notch in the test-bar used on the machine described came to a point on a small piece of graphite or a hard piece of cementite, it would cause a crack after receiving a blow, had rather astounded him. The photographs which had been shown to illustrate the distribution of the various constituents in cast iron were only pin-point pictures, and he could not imagine that one particular graphite flake or one piece of cementite could ever have the effect suggested. Finally, he asked Mr. Pearce whether he had been able to check up the results obtained with his impact-testing machine with anything else, such as the size of the graphite, phosphorus, manganese, or other factor.

Nature of Test-Piece Important.

MR. WESLEY LAMBERT (past Branch-President) said he was very interested in the tensile testing of cast iron, and had hoped that Mr. Pearce would have emphasised the fact that if one were preparing a test-bar of cast iron for a tensile test it must be as near as possible a perfect test-piece. Pronounced tool-marks, for instance, must be absent. With a material such as cast iron, which, with all due respect, he would call a rather brittle material, one must have a well-proportioned acting-length, preferably ground. The testing-machine must be in alignment and reasonably accurate. He considered any testing-machine as a poor one if not accurate to about 0.2 ton at any load up to 15 tons, or even 30 tons. Another point which he thought Mr. Pearce might possibly have mentioned was the relation of the acting-length to the cross-section of the test-piece. In the days of cast-iron guns, such as were used about the time of the Crimean War, the tensile testing of cast iron was introduced at Woolwich, and in the laboratory with which he had had the honour at one time to be connected, there were many hundreds of old broken tensile-bars of cast iron connected with the founding of cast-iron guns. Those bars were of 1-in. acting-length and 1 in. diameter; they were short, stocky bars. In later years, test-bars more in conformity with the B.E.S.A. specification were adopted, and it had been rather surprising to find that with the more modern type of bar lower test figures were obtained than with the older bars. In some instances he found that duplicates of the old bars were still intact, and he had been able to compare the thick, short test-bar with the ordinary B.E.S.A. specification bar. The results were in favour of a short acting-length and a thicker section than provided for in the B.E.S.A. specification. He believed this result to be due to the fact that there were very few testing-machines in which one could get a tensile test pull in true axial alignment, and, in testing a brittle material such as cast iron, it was essential that one should guard against, as far as possible, any bending moment in the test-bar.

The Wöhler Test.

With regard to the Wöhler test for cast iron, he found that one great difficulty was that of determining the relative stress which should be applied to the end of the rotating bar. They were given to understand that if they worked a material well within its elastic-limit it should go on practically for ever without failure, and in support of this, reference was often made to the hair spring of a watch, which was working well within its elastic-limit and continued to work for many decades. It was extremely difficult to determine the elastic-limit of cast iron, and if one did not know the elastic-limit one had more or less to use one's own discretion as to the stress that should be applied to the bar.

Compression Test of Importance.

Mr. Pearce, when referring to the "repeated impact" test, had talked of working the material "within its elastic-limit," but had not said how the elastic-limit of cast iron was to be determined, and he would very much like to know how Mr. Pearce arrives at the figure for the elastic-limit of a cast iron. Continuing, he said he was surprised that Mr. Pearce had not made mention of a compression test for cast iron, because he (Mr. Lambert) considered that, having in view the duty which cast iron had to perform for many engineering purposes, the compression test should come much more to the fore than it does at the present time. For cylinder iron a test was needed which would give some indication of its abrasive wear-resisting properties. Such a test was often needed more than a transverse, tensile, or impact test, and he asked Mr. Pearce whether he could give information regarding any modern testing-machine which would indicate the abrasive wear-resisting properties of cast iron, and one which would be likely to find favour with every-day engineers.

Repeated Impact Test Results Too Variable.

MR. H. C. DEWS agreed with Mr. Faulkner that the lecture had been the most interesting one yet given by a representative of the British Cast Iron Research Association, because it had got away from the theoretical standpoint of the university and had come nearer to practice. At the same time, he would like to know just where Mr. Pearce was trying to lead his hearers. He gathered that Mr. Pearce was putting forward his impact test as one which would indicate straight off the quality of the cast iron, but that, he considered, was rather in the nature of jumping to conclusions. In recent years there had been a great number of new-fangled tests put forward and adopted without any due measure of consideration being given to exactly what those tests indicated, and the impact test put forward by Mr. Pearce, he considered, was one of those tests. One did not know just what was to be learned from that test, and he felt certain that the number of blows was not the figure one should take notice of in determining the results of the test; there was something else. His experience of the Eden-Foster repeated impact test—which he gathered was similar to that described by Mr. Pearce—was that it was extremely difficult to repeat the results of a test,

XUM

and with that machine on more than one occasion he had had a test-bar break after half-a-dozen blows, whereas another bar, made of the same material, had needed as many hundreds of blows to break it. That seemed to indicate that there was something more in the test than appeared on the face of it.

AUTHOR'S REPLY.

Mr. Pearce replied both to Mr. Dews and to Mr. Gardom by disclaiming any intention to put forward any theoretical basis for his test; it was offered merely as an empirical means of separating irons which were claimed to be high duty irons. If two bars of the same metal gave widely differing results when subjected to the test, he would be inclined to argue that that was so much the worse for the iron—that one might find differences in the iron, such as differences of homogeneity, differences of rates of cooling, etc., which might conceivably explain the variation in the results. The figures he had quoted were, as far as possible, the averages of numbers of tests, and only in the case of the one Mr. Gardom had mentioned was the average widely different from the minimum and maximum figures. He did not know whether Mr. Gardom wanted to disparage the test when he had called it a laboratory test, but he himself considered that it was as much a works test as was the ordinary tensile or transverse test. The test bar was not unduly small, it did not want a great deal of preparation, and the test was easily carried out.

Replying to Mr. Faulkner, he insisted that microscopic cracks might very readily lead to a crack which might result in a fracture. It was not necessary for the hammer actually to strike the crack itself, but if it struck the neighbourhood of the crack it might very well set up a stress which would lead to a fracture. He had had no personal experience of the Frémont test, but did not like the idea of trepanning a very small test piece out of, presumably, a large casting, and testing it, because it seemed to him that that meant taking the very worst part of the casting for the purpose of test; the metal would be taken from that part of the casting where it could most easily be dispensed with, and in that case one would have the worst metal possible for testing. The results obtained with the machine he had described were not sufficiently numerous to enable them to be checked with the graphite, phosphide, or the composition generally. It was very difficult to get, in commercial irons, a sufficient number of bars to enable an experimenter to have one factor varying at a time. One would have to start with a plain, iron-carbon alloy, vary phosphorus, carbon, silicon, and so on, then vary the rates of cooling, and then the moulding conditions, which would be an extremely long job. Then someone would say that he was not working with cast iron, but with a synthetic or artificial mixture; one had to approach the matter from both points of view, and advance along both avenues at the same time.

Abrasion Testing.

He agreed with Mr. Lambert's remarks with regard to the tensile test, and believed he was quite right in saying that better results were obtained with the heavier section test bar for cannon. Apart from the alignment question, he believed the quality of the metal would be better, because the smaller the amount of metal removed by machining, the better was the result likely to be. When discussing the elastic limit, one was getting on to very debatable ground, but they had found, by carefully testing cast-iron bars, that a point was reached at which the extension ceased to be proportional to the load. For convenience, subsequent elongation was called "plastic distortion." He could supply the results of some tests on that. The question of resistance to abrasive wear was one of the most difficult it was possible to tackle, and the records of European laboratories had been littered for the last thirty years with reference to the efforts that had been made to determine an abrasive wear test. Apart from the great trouble of deciding whether the test bar really represented the casting, one got into difficulties in deciding whether to abrade the material or grind it away, and what type of test to adopt. One got into difficulties in deciding whether or not to lubricate the material; if one had a test in which there was sliding wear over two surfaces under lubricated conditions, one had reached practically service conditions, and would have to wait years for a single result. If one dispensed with lubrication, and so speeded up the results, one would obtain results which did not square with those obtained in practice, so that one would fall between the two stools. The B.C.I.R.A. had tackled the question in a limited way in order to determine to what extent abrasive wear was dependent on combined carbon. The problem was not so simple as that, because phosphorus and a number of other factors came in, but they had taken a number of comparatively small test pieces, comparable with piston-ring sections, and had run them on a cast iron table revolving at constant speed, and after a period of running the loss in weight of the test piece was measured. If the abrasive wear were plotted against combined carbon, one did obtain a very broad relationship. He must confess, however, that not only did the points cluster round the line of the curve, but there were a great many points which were off the line in both directions.

Mechanite Metal.

Mr. W. B. Lake, proposing a vote of thanks to Mr. Pearce for his Paper, said it was becoming generally recognised that of all the metals in common use cast iron was the one capable of most improvement, and very strenuous efforts were being made all over the world to produce a better cast iron. Therefore, it was of the greatest importance that we should have proper methods of testing the qualities of the various new irons which were offered, and the steps which Mr. Pearce and the Research Association were taking in the direction of finding these new methods were steps in the right direction. Referring to the American "Mechanite" iron, he said he was one of the members of the British delegation which had visited America recently. The delegation had been invited specially to hear the merits of "Mechanite" described by Professor Touceda, but his remarks were a little disappointing, for, although he had vouched for the accuracy of the test results shown, he had had to confess that he could not give the theoretical reasons why the metal should possess the qualities claimed for it. Discussing the impact testing machine described by Mr. Pearce, he suggested that there might be difficulty in making the notch in the test bars exactly the same in each case, and pointed out that they must necessarily be very finely finished if comparative results were to be expected.

Mr. H. O. Slater (Past Branch President) seconded.

The Branch President, who added his own personal thanks to Mr. Pearce, said he had felt for a long time that the ordinary tensile and transverse tests did not give sufficient information about the castings produced. Anyone who broke up castings was bound to notice the tremendous differences there were in metal from the same ladle. Some castings were almost unbreakable, but others, made of the same metal, and of exactly the same shape, would break very easily under the hammer. There must be some reason for that, and if the material were the same the differences must be due to differences in temperatures and cooling rates. He had been interested to hear that Mr. Pearce had been able to measure the elongation of cast iron. Occasionally one obtained transverse samples which could be bent, and that was particularly true of non-magnetic iron. He did not remember having seen anything like that ten or fifteen years ago, but such bars were obtained very often now with the better-class irons.

The vote of thanks was accorded with acclamation.

Mr. Pearce, replying to Mr. Lake, said that the tool used for making the grooves on the test bars dealt with by the machine he had described were special tools, and the finish of the bars was practically a mirror finish.

Some Recent Discoveries of Mediæval Tools.

The enormous rebuilding of late years, with the largely increased value of superficial areas, has caused immense cellars to be constructed, with the consequence of the turning up of many ancient tools long buried in the soil beneath the old structures. Most of these newly-found tools rest now in local museums. Though these discoveries add to our knowledge of the history of tools, the value lies mainly in the proof that the form of many tools has but little varied through a succession of centuries.

The tools used by mediæval workmen may, for the most part, be seen portrayed by various artists in illuminated manuscripts of many make the journey to the old inn in Pennyfarthing Street at Salisbury, to see the house in which the workmen, when building the Cathedral in the thirteenth century, used to be paid their wages on the Saturdays.

If one examines a number of mediæval bills, one finds payments for the main or greater things required, but we shall, as a rule, scarcely see one purchase mentioned of a single workman's tool, because such things were not found by the employers, but, as now, were the private property of the workman. The tools were not in every case known by the names we give them to-day. For instance, the gimlet was known often as a wimble, and ironmongers' travellers tell us that in some parts of the country the old names still survive to-day.

The carpenter's tools were framesaw, handsaw,

FIG. 1.—ILLUSTRATES A NUMBER OF MEDIÆVAL TOOLS, MOST OF WHICH STRONGLY RESEMBLE THOSE IN USE TO-DAY.

different periods. Almost all of these would be purchasable in the ordinary way in the mediæval ironmonger's shop. Of course, many tools are common to many classes of workmen; most use a rule, many a straightedge, and so forth, the use of the last-mentioned article being not wholly unknown to apprentices in quite a different sense from that of its usual application.

Though many tools are common to several classes of workmen, many tools in use by one class are wholly unknown to another. A mason, probably, would not know the difference between a male and female screw, a carpenter would not be able to define the distinction between a plummer block and a bedplate, and so on.

To those interested in the making of anything, be it a church, cup, or casting, any facts connected with the tools used in the fabrication must be of interest. Folk used many years ago to two-handled saw, brace and bits, gimlet, hammer, chisels, vice, gauges, mallet, nail box (and bag depending from the waist), dividers, straightedge, striker, square, smoothing plane, trying plane (but, oddly, no jack plane), rule and axe. A piece of string commonly hung with the other tools on a nail over the bench.

A recent discovery was that of the mediæval handle of a small handsaw. This was found with a monk's shoe behind the panelling of the fourteenth-century stalls of Winchester Cathedral when lately under repair. This handle is not unlike those in use to-day; we may suppose it to have been thrown down by the workman, possibly after he had fitted a new handle.

This handle is of the plainest possible description, being without ornament and consisting of a plain piece of wood forming the handle proper with another piece at a right angle, in a slot of

which the blade of the saw was inserted. The handle proper is about 4 in. long, the projecting piece in which the saw blade was inserted being about 6 or 7 in. long. From its simple form and the place in which it was found, it may perhaps date from the fourteenth or fifteenth centuries, and it is a very interesting and valuable survival.

A plane of 200 years ago was often of great length, whilst those of 400 years ago commonly had no handle.

The masons' tools were great and small saws, chisels, mallets, square, a combined hammer and stone cutter, a scraper with serrated edge and a long handle, hod with no stick, tub for mortar, baskets (to be pulled up by a winch and pulley), straightedge, dividers, striker, trowel, barrow and lead plum frame.

The recent discovery of a very essential part of a mason's equipment, a plum of lead, was made in Winchester Cathedral. This plum, now in the Cathedral Library, was taken out of the wall of the Norman transept when cutting holes for the fixing of a monument to a soldier who died in the Great War. The plum is of conical form, and stands some 3 in. high on its circular base. At the apex is a hole bored through to take the string.

The foundryman's appliances and tools were the patterns, rake, sieve, sand, smoothers of many forms, knives, beads, cleaners, trowels and moulding boxes. The patterns would be, of course, made by the pattern maker, whose rank as a workman differed little from that of a cabinet maker, and whose tools differed not very greatly from those of a carpenter.

The metal workers' tools were the graver, hammer, dividers, rule, punch, shears, chisels, mallet and lead bed.

The hammer is one of the most ancient of tools. Examples still remaining in many of our museums show it to have retained its form for nearly twenty centuries in this country alone. A fine specimen is that which, made some 2,000 years ago, is now in the Museum of the City of London, and so far as its appearance goes, might well have been purchased yesterday at any ironmongers.

This hammer is a shade larger than those ordinarily used, being about 6 in. across the head and the same length in the shank, where it was fixed in the usual way on to the handle. This hammer head, buried in London City soil for many centuries, has too far rusted away to be of service again.

Many more tools of a similar period and of modern form remain to-day—axe heads, chisels, gauges, and ploughshares, etc., the latter being far smaller than those in use at the present time.

Spring-back shears remain of the fifteenth century of various sizes and of the same appearance as those of to-day, so, too, iron staples. Planes, pincers, dividers, compasses, hammers, braces without bits, vices and saws, all of different sizes, which were made some two or three hundred years ago, of steel and iron, remain. All these are of a form which would excite no comment if placed in a shop window to-day.

It is a tradition in pattern shops that a tool, old or buried for long under a floor, has a better edge than one newly purchased. If such be the case, these centuries-old tools should be of much value for actual service.

Our illustration is a reproduction of the fine picture on page 27 of the British Museum MS. 19720 of the fifteenth century. It shows us more than a dozen different workman's tools of old time. It shows stickless hod, plum frame, two-handled saw, ladder, spade, tub for mortar, winch, adze, scaffolding, foundation digging, barrow, basket, masons at their work, hammer, trowel and beetle. This last tool is very clearly shown, and being one of the most ancient of tools, it is of more than ordinary interest. For more than 1,000 years the beetle has been wielded by Englishmen in London and throughout the provinces. The tilers have not yet arrived, but the tiles are shown stacked ready for them. With the whimsical humour so common in drawings of the Middle Ages, the man on the ladder is depicted with grave mien and aspect engaged on a serious task—*he is bringing up the beer!*

Steels for Structural Purposes.

In the course of a Paper on "High Elastic Limit Steel for Shipbuilding and Marine Engine Purposes," read by MR. T. M. SERVICE before a meeting of the Institution of Engineers and Shipbuilders in Scotland at Glasgow on December 21, the author pointed out that the Admiralty specification drawn up as a result of their large-scale experiments and ordinary commercial tests at Greenwich, for special structural purposes, was as follows: (1) Limit of proportionality, 17 tons per sq. in.; ultimate tensile strength, 37 tons per sq. in.; elongation on 8 in. lengthwise, 17 per cent.; crosswise, 17 per cent.; bend on a section $1\frac{1}{2}$ in. × thickness of plate, and must go round to 180 deg. over a radius equal to $1\frac{1}{2}$ times the thickness of the plate.

A specification drawn up by Lloyds and the British Corporation, for steel for special structural purposes, conformed to the following: Limit of proportionality, 15 tons per sq. in.; ultimate tensile strength, 33 to 38 tons per sq. in.; elongation on 8 in.: Lengthwise, 20 per cent., crosswise, 20 per cent.; bend on a section $1\frac{1}{2}$ in. × thickness of plate, 180 deg. For bridge and similar construction work, either the Admiralty specification or Lloyds specification could be used.

Investigation of steel ingots, plates, forgings, etc., demonstrated that steel was anything but a homogeneous material. The quality of steel for the two classes—mild and special—was different, and depended on the type of mould into which the material was to be cast. Mild steel was generally run into cast-iron moulds without any refractory head. Consequently, steel which tended to form blowholes rather than pipe deeply was preferred. The special-quality steel was what was known as deep piping, and was cast into iron moulds which had the wide end uppermost, and on this was superimposed a head lined with brick or other refractory material.

It was absolutely imperative in special steel to have the material as solid as possible, and free from surface blowholes, so that the special properties, high limit of proportionality and toughness, would be uniform through the resulting product. To get the structure into the best physical condition, was governed by the after-treatment. The generally accepted idea was that heating for rolling was only necessary in order to shape the material, but later metallurgical investigations had proved that heating was part of a thermal treatment, and that, in order to have complete diffusion of the carbon, it was necessary to heat the material to a definite temperature and for a specified time. It was fortunate that the temperature necessary for this structural transformation was high, and any shaping, such as cogging or rolling, could be completed, and still permit the finished product to retain sufficient heat to allow of a rearrangement of the crystals, before the mass had passed through the Ar_1 point on cooling.

THE ANNUAL DINNER of the London Iron and Steel Exchange, which will be held on February 8 at the Savoy Hotel, ranks as one of the most popular social gatherings of the iron and steel trade. This year considerable interest will be added to the function by the presence of a number of railway officials. Sir Ralph Wedgwood, the general manager of the London and North-Eastern Railway, and Sir Felix Pole, the general manager of the Great Western Railway, will be amongst the guests, and the former will reply to one of the toasts. The Master Cutler of Sheffield has also accepted an invitation, as well as Mr. John Craig, of David Colville & Sons, Limited, and Mr. F. W. Harbord, the president-elect of the Iron and Steel Institute. Sir Wm. Larke, of the National Federation of Iron and Steel Manufacturers: Mr. L. D. Whitehead, of the Whitehead Iron and Steel Company, Limited, Mr. V. C. Faulkner, president of the Institute of British Foundrymen, and Mr. Robert Dennison, M.P., the assistant secretary of the Iron and Steel Trades Confederation, will also be present. The attendance at these annual dinners has increased steadily during the past few years, and the number at this year's dinner seems likely to constitute a fresh record. A first-class musical programme has been arranged. Mr. H. J. Skelton will preside.

American Foundry Practice.*

By W. Jolley.

Obviously, although the author's visit was of somewhat longer duration than those of his colleagues who took the opportunity to attend the Detroit Conference, it only covered a period of seven weeks, including the voyage out and home, and during this time he was able to visit only six States out of a total of 52, and less than 40 foundries out of some 5,785 which statistics show to exist in the United States, and consequently it is impossible to give other than a brief outline of the foundry life of America.

These visits commenced on September 21 and concluded on October 21, and an effort was made to make them as representative as possible by including foundries dealing with iron, steel, brass, etc., both of the jobbing and repetition variety.

The visits were both in company with others of his party and also alone, and as opportunity was afforded of visiting some of the works closely allied with those of the company with which the author is associated and conducting personal inquiries, he was able to make critical comparisons advantageous to both parties as well as to himself.

Huge Productions and Orders.

Much has been written in regard to American methods, and it is largely correct, but our difficulty in appreciating its real meaning is due to our inability correctly to focus their conditions. It is difficult for Britishers to form a correct impression of an output of 1,500 tons of castings per day, or of an order for 3,000,000 castings, both of which are actual facts.

In their general jobbing foundries there is a very close resemblance to our own shops. In these shops, as in their repetition shops, there appears to be an absorbing consideration of labour conservation so far as the skilled moulder is concerned, and we see that the skill of one man is generally utilised in the control of a number of less skilled men, resembling to a somewhat exaggerated extent the gang method operated in some shops in this country. Thus they are able to make the best use of what skill is available, but little opportunity is afforded to develop a future generation of moulders.

Largest Castings Not Wanted.

One of the shops visited was engaged on some very big castings, weighing as much as 100 tons, but generally speaking efforts are made to reduce the size of castings by splitting them up into several pieces. Loam work is met with less frequently than in this country, although in some shops it is largely used, particularly upon such work as condensers, etc. In this respect Britain is probably more advanced, as there was no evidence of the use of either prodded or barred tackle, the old method of ramming up in pits being still in operation.

Sand Cutters.

Various types of moulding machines, such as sand slingers, and jarring machines, were met with, but opinions differed as to their advantages. Great use appears to be made of sand cutters for assisting to condition floor sand, and in several foundries visited they were in operation. There is unquestionably more endeavours made in the larger foundries at any rate to reclaim used sand. Thus with the aid of these tractor sand cutters, the whole of the floor is cut up and treated or the sand is conveyed to the sand plant, where it is restored with powdered dry clay, and treated by one or more of the mechanical devices used for milling purposes. In this way sand is reclaimed, and its properties such as bond and porosity maintained at standard.

Sand Reclamation.

It is doubtful whether it would be a paying proposition so to deal with our sand in this country. The technical work necessary efficiently to determine and closely watch such a process would be a heavy burden in view of the almost unlimited sand resources at our disposal. In America, however, sand appears to receive especial attention, and there is an almost widespread use of both handling and mixing devices, more or less complex, and one is made to wonder what finish could be obtained were we to adopt even some of their simplest methods of treatment.

Needless to say, some of these devices are admirable in their utility, and could and should be operated in our foundries to the ultimate good of our product. It is very well known that the British founder suffers much from the lack of attention given to sand, and to his apparent indifference to the demands of the engineer. It is, however, in regard to mass production work that the American founder has given and constantly gives special attention, and in this respect we have been left far behind.

Influence of Quantity Production.

Quantity production resulting from a more standardised product and a wide market has undoubtedly given him a decided advantage, and has enabled him to give concentrated attention and thought to highly specialised machinery and methods. Added to this is the readiness with which he replaces his machinery for more modern types with its consequent increase in production, and decrease in cost without any decrease in quality, and their machine castings have attained a high standard of excellence. This is all the more remarkable when one considers the unskilled and cosmopolitan nature of the labour available. Europeans from the more backward nations, and coloured men from the Southern States, men with a roaming disposition, almost entirely comprise the available labour. There appears to be an ever-present desire to move, and consequently great thought has been brought to bear upon shop lay-out and simplicity of operation.

Production Cheapens Research.

The job has been made to suit the man, and the immensity of the demand has materially assisted in this direction. It has made research economical and the installation of expensive machinery a necessity. In this direction there is the development of the conveyor and the sand handling plant. In the larger and more modern foundries there are conveyors of various descriptions, and where these are applied we see the added advantage of a decreased area of floor room per man. The sand-handling plants are of both the overhead and underground type, the latter method appears to have found great favour, although where the lay-out makes the overhead type possible it is used with advantage.

Extensive Use of Conveyors.

In one of the shops visited, the sand was knocked out of the boxes after casting over a grid, and conveyed by means of a belt and screw arrangement to the mixing troughs. After passing through these troughs it was still further conveyed to an overhead gallery and deposited in chutes, which in turn continuously supplied the moulders with reconditioned sand. This method particularly suited their general layout and greatly diminished their general labour. Similarly, belt conveyors were used for conveying moulds to the point where the casting took place, the mould being placed upon the belt and conveyed along, and after casting continuing along to a point over a grid where it was knocked out.

The casting passed to the dressing shop and the boxes were placed upon a second conveyor and returned to the moulders. Later it is hoped to describe this in detail in dealing with the Ford plant.

Moulding Boxes.

Although moulding boxes were used in some shops, great advantage was taken of snap flasks and taper flasks. Of course, these are not an

* A Presidential address given to the Junior Section of the Lancashire Branch of the Institute of British Foundrymen. The author is the General Manager of the Foundries of the Metropolitan Vickers Company, Limited.

innovation, as they are, and have been, in constant use in some foundries in this country for a number of years. Their advantage lies in the fact that they do not involve a large capital outlay and are more easily stored than moulding boxes. This is best illustrated by the consideration of a daily output of 3/400 moulds per day from one man, a figure readily obtained on a suitable machine.

Types of Moulding Machines Used.

Casting conditions may necessitate this number of boxes, where the snap-flask method would only necessitate one flask, and possibly a dozen light slips for use during casting. There are many types of moulding machines in operation, including power-press and hand-ram types, such as sand slingers, Tabor, Pidmore, Arcade, Mumford, Hermann, Osborne, etc., and each of them possess advantages differing according to conditions, and great use is made of them, as will be understood from the above remarks.

The Ford Motor Co. Methods.

The Ford Works are described at very great length in the several publications from the pen of Mr. Henry Ford, and it is therefore only necessary to describe some of the details given during the visit and to give personal opinion of the inspection of their plant. The Company started operations in 1903 with an output for that year of 195 cars. This had increased to such an extent that in 1925 over 2,000,000 cars were turned out. They employ approximately 150,000 men in America. Their interests include coal mines in West Virginia and Kentucky, together with iron-ore mines and forests in Northern Michigan. They operate their own blast-furnace plant, steel mills, machine shops, body-making plants, saw mills, coke ovens, cement plant, paper mill, glass works, Fordson tractor plant, loco repair shops, whilst they have their own railway system and docks. From this it will be readily understood it is a gigantic undertaking, built up and controlled by a master mind.

Their Highland Park Works occupy 278 acres, 105 of which are under roof, and approximately 50,000 men are employed. There is a very large brass and white metal foundry, where great use is made of die-casting plant both in white metal and aluminium. Quantity production enables them to spend much money both in plant and dies, and some of these are elaborately designed to ensure complete mechanical operation. One of the most interesting features met with here is the "waste eliminating department," and from this one can learn much towards increasing the efficiency of a works. Everything that can be included under the term "scrap," and is considered to be of no further use by the department concerned from which it emerges, is sent to this eliminating department, where it is scrutinised and an opinion is formed in regard to its utility.

Work may be done upon it and its original purpose transformed in some way, and as a result of this it was understood some £250,000 worth of material is returned to the works each month. This is truly a wonderful achievement, and a striking lesson of what can be done with material which has once been considered scrap.

River Rouge Works.

At the River Rouge Works some 55,000 men are employed, and this number is ever-increasing. It is difficult to do justice to these works, but a few particulars of the foundry will be welcomed by foundrymen. This foundry is the most complex place in the whole organisation. Mechanical methods are present to such an extent as to bewilder one. The output of castings was something in the neighbourhood of 1,500 tons per day.

Any comparison with domestic outputs will help one to realise how difficult it is to form a true conception of what such an output as 1,500 tons per day will involve. And yet their organisation is so efficient, and their layout so complete and orderly, that it appears to be easily achieved. Very little daylight is available, almost all work being done by artificial light. One of the first causes for amazement is the comparative absence of sand. We in this country cannot conceive a foundry without associating it with huge quantities of sand, in fact, we are accustomed to being surrounded with sand, and consequently cannot, or do not, give it its proper purpose; but at the Ford Works there are no sand floors such as we have. It is conveyed direct to the box or flask by means of chutes served by overhead conveyors. The moulds are made by the multiple method, that is, each man does so much, performs a specific operation, and as a result of the collective operations the castings are made.

The cylinder block was rammed up by a sand slinger, yet there were seven men stationed around what is termed a "roundabout," and each doing some definite operation in the ultimate production of the perfect core. As a result of their efforts three cores per minute were placed upon the conveyor. The copes were rammed up on jar-ram machines and cylinders were being cast at the rate of 180 per hour per conveyor, of which there were six sets.

After being cast, which operation takes place whilst the mould is still on the conveyor, the mould continues its journey for some distance to a point where the box appears to do the Charleston, and is deflected off the original conveyor on to a secondary conveyor. During its progress thus, it has passed over a grid where the sand was knocked out and sent upon its journey for reconditioning.

At this point two men are stationed, deflecting the now empty box on to the original conveyor on its return to the moulders. Thus they are in continuous use. The casting by this time is well on its way to the dressing shop. To get there it travels a great distance, and during its progress it is subjected to a very keen inspection at the hands of a host of inspectors stationed along its course.

There were about seven inspectors, each scrutinising some particular part of the casting, and each provided with a conveyor siding along which he sidetracks any casting which does not meet with his approval. Such castings as pass this inspection ultimately reach the dressing shop.

Dressing Shop.

This department is staffed by coloured labour, divided into operation groups, the first of which is the coring gang, who push out the cores and pass the castings along to the fettling gang.

Final dressing having been done, the castings again pass along for further inspection before being eventually despatched to the departments requiring them. During the whole of this time, from the delivery of the sand to the moulder and the tapping of the metal at the cupola, nothing appertaining to the casting has touched the floor, and even at the final stage alluded to, *i.e.*, delivery to the machine shop, the castings are still hot.

A 50-ton Electric Furnace.

The cupola plant is a source of amazement, and consists of 36 cupolas, each of 100 in. diameter, and are used in batches of 18 per day. Can you visualise what this means? These cupolas are charged by hand, which is not in accordance with the latest American practice, but it is Mr. Ford's opinion that this operation cannot be efficiently performed by mechanical methods, a belief in which he is not alone.

It was their original intention to cast direct from the blast furnace, but after an extended trial it did not prove a success.

They are at present installing a 50-ton electric furnace into which it is intended to tap direct from the blast furnace, where it will be refined and sent to the foundry. By this means "pigging" and the consequent hand-charging methods will be eliminated and a considerable saving effected.

The amount of machinery such as chutes, conveyors, mono rails, etc., makes one wonder to what extent mechanical methods can be economically used, but everything appears efficiently to perform some necessary function in a wonderfully organised system.

Carburettors.

The carburettor for the Ford car is made by the Holley Carburettor Company by means of their "Longlife" mould process, who were engaged upon an order for 3,000,000 of these castings. This method has been described in recent foundry literature and through other channels.

MACNAB & CO.

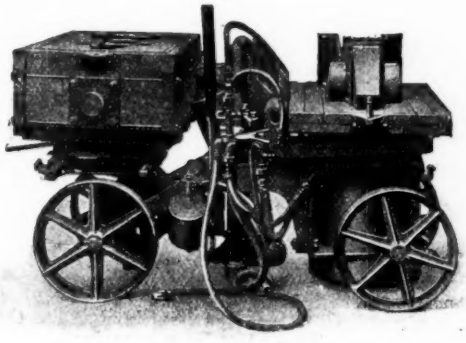
BRITISH MANUFACTURE THROUGHOUT

Tabor Patent Portable Combination "Shockless" Jarring Roll-over and Pattern-Drawing

MOULDING MACHINE.

PIONEERS FOR 40 YEARS

THE TABOR RANGE OF MOULDING MACHINES Combine THE WELL-KNOWN TABOR QUALITIES



The Finished Mould—showing Pattern after being drawn.

FLEXIBILITY—ECONOMY—SPEED

DURABILITY & EFFICIENCY

CAPACITY.

SIZE	*Size of Moulding Box.	Straight Pattern Draft.	Nett Weight of load that can be rolled over at 80lbs. pressure.
18	18 in. wide 36 in. long 12 in. deep	8/10 in.	450 lbs.
24	24 in. wide 48 in. long 15 in. deep	10/12 in.	800 lbs.

Special Features and Advantages.

Sand jar rammed by "Shockless" device—Tabor Patent—without shock to the machine or surrounding moulds.

***Machine not restricted to use of one size moulding box—any size can be used up to load capacity of machine.**

Good surface castings.

Pattern plates can be changed instantly without unfastening mechanism so that comparatively small quantities can be made economically.

Perfectly straight draw ensured by mechanical guides of large surface to prevent wear and retain accuracy.

All moulds jar rammed in a few seconds and thoroughly uniform in density, ensuring minimum quantity of defective castings and less blow holes.

All operations other than sand filling are completed in two minutes for any size of work within capacity of machine. To realise what this means, compare your present wage cost for the same work!

We make various models and sizes for all types of machine moulding, according to class of work and numbers.

SEND US DRAWINGS OF YOUR WORK FOR SPECIFIC EXPERT ADVICE, :: ACCORDING TO YOUR CONDITIONS AND QUANTITIES ::

56/8, EAGLE ST., SOUTHAMPTON ROW, LONDON, W.C.1.

WORKS: TOTTENHAM, LONDON, N.17.

Code: Western Union.

but perhaps a brief description will be of advantage. The moulds or dies, 16 in number, are arranged on a circular turntable, and are first treated with a composition which gives a white coating to the dies. These are then revolved and brought to a position where they come into contact with an acetylene flame, which causes a deposit of soot. Continuing their revolution around the table, such operations as the insertion of cores, closing of mould, casting, removal of casting, etc., in ordered sequence are performed. The castings so produced are then in what is known as a "white" condition, and, as such, machining is impossible. They therefore go to an annealing oven and go through the process of annealing for a period of 45 minutes. A rearrangement of their plant, now in progress, will result in the production of these castings without any handling previous to being annealed.

At another large and comparatively modern foundry similar use of mechanical methods were in operation. Moulding machines of one type only were installed. These machines were located under a sand-handling equipment which maintained a constant supply of sand in an overhead bin, so arranged that the operation of a lever caused the liberation of sufficient sand to fill the flask exactly on the moulding machine. Conveyors similar to those already described were in operation, and even runners and risers were similarly dealt with and returned to the cupola by this means.

Very great care was taken to ensure that correct metal thicknesses were obtained, and with this object in mind some of the cores used had their joint surfaces ground on Churchill grinders after assembling to ensure the correct depth of the assembled core. Defective castings were carefully inspected, and such as could be recovered without any ultimate risk were heated up in stoves and welded. This is a line of thought to which we should give some attention in this country. They also possessed a very large modern brass foundry in which 12 electric furnaces were installed.

Malleable and Steel Foundries.

In such details as have already been dealt with, similar conditions apply in the malleable and steel shops. Sand cutters are in operation, as also are similar sand-mixing plants. Beyond this, however, there are the annealing methods in operation in the malleable shops. The several shops visited were in some cases equipped with annealing furnaces fired with pulverised fuel, whilst others were gas fired, one annealing oven being 167 ft. long with a conveyor running through.

Elaborate temperature control was practised during the annealing operations, and the operations differed inasmuch as some firms used packing material during annealing whilst others did not.

Core Shops.

The author paid special attention to the core shops, and found that greater use was made of machinery in this department than is the practice in this country. He was particularly interested in, and more than a little convinced by, the efficiency of a blowing machine which he had not previously encountered. There were several types of these machines, but he was greatly impressed by the work done by one of these types, of which the construction was very simple and which appeared to give a correct core. Repetition work is necessary if these machines are to be efficient, and owing to the sand being deposited into the boxes by means of compressed air, metal boxes are essential. Careful consideration has to be given to their design, and intricacies have to be specially considered. Speedy output is easily obtained, and probably its use can be widely applied.

Core-shop design and arrangement appear to receive very careful consideration, and they are probably far in advance of our own. In the first place greater use is made of core-making machines, similar to the ones just described. Metal core-boxes are very largely used, care being taken both in their design and manufacture to ensure the most perfect cores. Drying arrangements are very efficient, and the old-fashioned coke-fired stoves, so common in this country, are rarely if ever met with. Instead of this, gas firing or hot-air drying is usually installed. In one of the foundries visited the author was fortunate enough to find one where electricity was used as a medium for providing the necessary heat. It was somewhat novel in design and closely resembled our present-day electric cooking stove used for domestic purposes, except that the shelves were of the revolving type.

Temperature Control.

Temperature control is very largely in evidence, and is very closely adhered to In some shops oil-sand cores are solely used; in one instance, where radiator castings were manufactured, it was stated they used 100 tons of oil sand per day. In many instances the cores are fixed in cradles whilst being dried.

Stocking and Distributing Cores.

Particular attention appears to be given to maintaining a dry atmosphere for the purpose of stocking cores. This obviously reduces a period of waiting time whilst the cores are being made, and to make this possible underground fires are arranged in their stock room, consequently their cores are not subject to moisture variations and its harmful effects. The distribution of cores has also been closely studied, and in many instances they are conveyed about the shop upon telphers fitted with spring trays, which considerably diminishes the possibility of damage during handling.

Sand Control.

Sand control was a special point of interest as it is so largely neglected in this country. The milling and distributing operations have been mentioned, but the steps taken to ensure the best conditions of the raw material are of paramount importance. Of course, this is governed by the nature and size of the shop, but it is given close attention in some of the largest and more modern shops, and advantage is taken of the standard tests as applied by the American Foundrymen's Association. In this test a weighed quantity of sand is subjected to a standard method of ramming and the difference in the length or height of the resulting body of sand when compared with a standard figure for dry sand indicates the amount of moisture present, as it is well known that the moisture present governs the closeness of the ramming. These cores are then placed under a permeability test, which consists of passing a known volume of air through the core and the time taken for its passage indicates its permeability.

A third test is then applied for the estimation of the strength, when pressure is carefully applied by means of a recording press, and the pressure applied before the collapse of the core indicates the bond of the sand.

Some of the foundries exercise very great care in controlling the moisture content of the raw sand, and in one of the shops visited provision was being made by the erection of 10 huge ferro-concrete covered bins for the storage of some 2,000 tons of sand. This was a striking contrast to the usual crude methods so common over here.

(*To be continued.*)

New Members for the B.C.I.R.A.

The following firms have recently joined the B.C.I.R.A. In brackets we give their representative:—The Callendar Iron Company, Ltd., Falkirk (Mr. R. Kidston); Sidney Flavel and Company, Limited, Leamington (Mr. S. W. B. Flavel, B.Sc.); Harper, Phillips and Company, Limited, Grimsby (Mr. E. A. Phillips); Peter Hope, Tyldesley (Mr. Peter Hope); Lake and Elliott, Limited, Braintree, Essex (Mr. W. B. Lake, J.P.); Mond Nickel Company, Limited, London, S.W.1 (Mr. W. R. Barclay, O.B.E., A.M.I.E.E.); Yorkshire Repetition Castings Company, Limited, Laisterdyke, Bradford (W. G. Thornton); and Morris Motors (1926), Limited, Coventry (Mr. F. G. Woollard).

AN IMPORTANT STEP in the progress of the iron and steel trades of North Lincolnshire is marked by the production this week of the first steel from the new plant of the Appleby Iron Company, Limited.

BLACKING,
PLUMBAGO,
CORE GUM,
WHITE DUST,
COAL DUST.

ESTABLISHED 1863

JAS. DURRANS & SONS, LTD.
PHOENIX WORKS, PENISTONE, near SHEFFIELD.

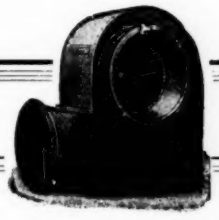
Telephone :
21 PENISTONE.

Telegrams :
"DURRANS, PENISTONE."

Manufacturers of
FOUNDRY EQUIPMENTS

LADLES,
FIRE BRICKS,
STONE FLUX,
CASTING CLEANERS,
PIPE NAILS,
SPRIGS,
WIRE BRUSHES,
BELLOWS,
CUPOLAS,
GANISTER,
LOAM AND SAND MILLS,
STUDS,
CHAPLETS,
BRUSHES,
CORE ROPES.
BUCKETS,
SPADES, Etc.

Write for Illustrated Catalogue on Blacking and Foundry Requisites, also for our latest Price List.



40 Years' Experience in the Design & Construction of Fans *for*

Heating and Ventilation of Buildings, Mines and Ships,
High Pressure Blast for Forges, Furnaces and Cupolas,
Mechanical Boiler Draught,
Fume and Steam Removal,
Dust Removal and Collection,
Cooling and Drying Plants

means **Expert Knowledge, High Efficiency, Reliability & Good Service**

Davidson's the TRADE SIROCCO MARK **Fan Makers**

have an experience covering hundreds of different industries and hundreds of different uses, and they can furnish a Sirocco Fan for every purpose for which a fan can be employed.

Solve your fan problems by using the Sirocco Service.

DAVIDSON & Co. LIMITED
SIROCCO ENGINEERING WORKS - BELFAST
LONDON - BIRMINGHAM - CARDIFF - BRISTOL MANCHESTER - GLASGOW - NEWCASTLE

Trade Talk.

FERRANTI, LIMITED, Hollinwood, Manchester, have orders for ten transformers of 4,000 kw. each for the London Power Company Limited.

THE WHITEHEAD IRON AND STEEL COMPANY, LIMITED, Tredegar, Mon., are supplying all steelwork for the Perak Hydro Power Station, Federated Malay States.

THE METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, Trafford Park, Manchester, are supplying 104 motors, each of 230-h.p., for the Northern Railway of Spain.

AN INTERESTING review of post-war conditions in one of the basic industries was given by Sir William J. Larke, director of the National Federation of Iron and Steel Manufacturers, in the course of an address on "The Iron and Steel Age," at a meeting at the University, Edmund Street, under the auspices of the Birmingham Municipal School of Commerce.

AT THE MEETING of the Diesel Engine Users' Association, which was held on February 4, the newly-elected president, Mr. Geoffrey Porter, was in the chair. The Committee's Report on Heavy-Oil Engine Working Costs for the year 1925-26 was discussed. Other matters which were brought forward for discussion were the question of compressed air receivers as affected by the proposed regulations under the new Factories Bill, and a method of repairing a broken crankshaft on a Diesel engine.

IN HIS REPORT to the National Union of Blastfurnacemen, Mr. Thomas McKenna, the general secretary, says that all the disasters which have befallen their union have been the result of other people's disputes. In view of the general suffering brought about by sectional disputes, he thinks it time that they, as trade unionists, should devise some system and policy by which they may not only share in the sufferings brought about by a strike or lock-out in another industry, but may share in the consultations, responsibilities, and considerations in regard to their entry into other disputes, and, at least, have a right to advise in the conduct of any negotiations pursued in such quarrels.

THE GREAT SOUTHERN RAILWAY OF IRELAND have decided to equip their main line depôts at Inchicore, Ballybrophy, Limerick, and Cork with water-softening installations of the most modern type, and have placed the entire order for this work with United Water Softeners, Limited, of Aldwych House, London, W.C.2. The Sudan Government Railways and the Great Indian Peninsular Railway have also placed orders for softening installations with United Water Softeners, Limited, the water softener adopted in all three cases being the Lassen-Hjort lime-soda system.

REPORTS PRESENTED at a meeting of the Cleveland District Board of the National Union of Blastfurnacemen, Ore Miners, Coke Workers and Kindred Trades showed that 42 blastfurnaces had been restarted following the coal trouble, and that there were prospects of another dozen furnaces being put into operation in the near future. In addition, six coke-oven plants had been got under way, and the general activity in the industry was already greater than in April last, just prior to the stoppage. The speed and smoothness with which the plants had been got going was a tribute to the keen and efficient management, as well as to the relationship between the employers and the employed.

THE ELECTRICAL INDUSTRY, in spite of the severe industrial crisis which reigned throughout the last eight months of 1926 as a result of the coal stoppage, has had a record year both at home and abroad, states the British Electrical and Allied Manufacturers' Association. All branches of production, with the exception of the industrial motor section, have been working full time; thousands of new employees have been engaged to cope with the increased demand, and the leading firms now report that they have work on hand sufficient to last for fifteen months. The orders received for generating plant on home account, due to the new super-power stations being erected in London, Coventry, Bristol, Oldham, Birmingham and Kearsley in preparation for the national power scheme, were 24 per cent. higher than in 1925, and only 6 per cent. below 1920. On export account the increase over 1925 was 22 per cent., and over 1920 43 per cent., while, for the entire range of business, 1926 was 10 per cent. above all previous records.

THE ROYAL METAL TRADES PENSION AND BENEVOLENT SOCIETY held their sixty-sixth annual dance at the Hotel Cecil, last Friday week, the chair being taken by Mr. F. Malcolm Garnham, of J. B. Garnham & Sons, the well-known metal merchants, of 44-47, Devonshire Street, Theobalds Road, London, W.C.1. As usual this annual affair took the form of a supper dance, at which about 400 visitors were present, amongst whom the following well-known members of the trade were noted:—Messrs. H. E. Austin, E. A. Endicott, A. K. Stevens (chairman of the board of management), H. E. Robey, Geo. Calubriad, T. S. G. Ramsey, A. J. Dearberg, Edw. A. Goddard, F. A. B. Lord, Ed. E. Starke, James Whitby, J. W. Horne, H. D. Meredith, Chas. F. Gray, and Stafford Hodge. At the conclusion of the supper, the chairman, Mr. F. Malcolm Garnham, toasted the Royal Metal Trades Pension and Benevolent Society and The King, in the course of which he mentioned that the objects of the Society were to assist all members of the metal trades, as regards pensions, temporary financial assistance, etc. Since formation the Society has assisted upwards of 2,200 persons, to the extent of £275,000. At present there are 260 pensioners on the books, necessitating an expenditure of £135 per week. Mr. Garnham pointed out that to enable the Society to carry out their objects it was necessary that subscribers should whenever possible make their subscriptions and donations a fixed annual sum, in order that they would be in a position to ascertain their income and so allocate the expenses accordingly. At the conclusion of his speech Mr. Garnham called for a toast for Mr. A. K. Stevens, for the services rendered in connection with his position as chairman of the board of management. In responding Mr. A. K. Stevens emphasised the objects of the Society, and pointed out that the success of these dances were due mostly to the efforts of Mr. Farmer, the secretary.

Contracts Open.

Belfast, February 9.—(1) Iron, (2) iron castings, (4) bolts, spikes, etc., (5) tyres and axles, (6) springs, steel and files, (7) nails, screws, etc., (8) carriage fittings, for six and 12 months from March 1 next, for the Belfast and County Down Railway Company. Mr. H. E. Mellor, secretary, Queen's Quay Terminus, Belfast and County Down Railway Company, Belfast.

Coventry, February 21.—(4) Iron castings for 12 months ending March 31, 1928, for the General Works Committee. Mr. E. H. Ford, city engineer and surveyor, Council House, Coventry.

Dundee.—Iron railings, for the Dundee Town Council. Mr. G. Baxter, director of housing, 91, Commercial Street, Dundee.

Gosport, February 14.—Castings for year ending March 31, 1928, for the Town Council. The Borough Engineer, Town Hall, Gosport.

Durham, February 14.—(3) Cast-iron direction posts; (4) wrought-iron motor signs and symbols; (5) gully grates and frames, etc., for year ending March 31, 1928, for the Durham County Council. Mr. W. J. Merrett, county engineer and surveyor, 43, Old Elvet, Durham.

London, E.9, February 9.—(5) Iron and ironmongery, (8) sewer ironwork, from April 1, for the Hackney Borough Council. The Borough Engineer and Surveyor, Hackney. (Fee, £1 1s. in each case, returnable.)

London, S.E.1, February 11.—(3) 11,400 cast steel or malleable cast iron axleboxes for railway stock, for the Director-General, India Store Department, Branch No. 14, Belvedere Road, Lambeth, S.E.1. (Fee, 5s. per set, non-returnable.)

London, W.4, February 7.—Pipes, gullies, etc., for the Urban District Council for 12 months commencing April 1. Mr. E. Willis, engineer and surveyor, Town Hall, Chiswick, W.4.

Melbourne, February 23.—20-h.p. oil engine (Contract No. 40193), for the Victorian State Railways. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. A.X. 4126.)

Pudsey, February 5.—600 yards of 6-in. spun or cast-iron water pipes, tested to 600 feet head. Mr. A. E. Evans, town clerk, Town Hall, Pudsey.

Rocester, Staffs, February 14.—1¼ mile of cast-iron water mains, together with 80-ft. span lattice girder bridge, etc., for the Uttoxeter Rural District Council. The Surveyor's Office, Town Hall, Uttoxeter. (Fee £3 3s., returnable.)

Salisbury, February 9.—Iron castings during one year from April 1, for the Town Council. The City Engineer and Surveyor, Endless Street, Salisbury.

Stafford, February 12.—(11) Castings, for the Corporation. Mr. W. Plant, borough engineer, Borough Hall, Stafford.

Sydney, N.S.W., April 4.—One travelling jib crane and grab, for the Electricity Department of the Municipal Council of Sydney. The Department of Overseas Trade, 35, Old Queen Street, London, S.W.1. (Ref. A.X. 4148.)

Torquay.—Two vertical circulating water pumps, for the Town Council. Mr. H. F. G. Woods, borough electrical engineer and manager, Electricity Offices, Upton Valley, Torquay. (Fee £1 1s., returnable; extra copies 10s. 6d. per copy, non-returnable.)

Tadcaster, February 7.—Cast-iron water mains, with valves, hydrants, etc., for the Tadcaster Rural District Council. Mr. E. Thackray, water inspector, Station Road, Kippax, near Leeds.

GENERAL REFRACTORIES CO., LTD.

SHEFFIELD

"SERVICE GRC FIRST"—PYROLYTE OFFERS A REAL SERVICE.

Come Wail- Come Woe!

"Raising his voice in repining"

If a man in a furnace shall pause from his lining,
And, dropping his brick, raise his voice in repining,
You shall say to him, "Bill!
Now what is your will?
Say, what is your woe and why are you whining?"

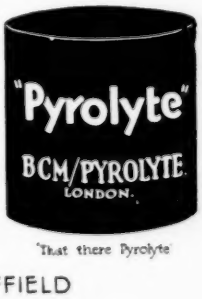
If William's the man that I have in my mind
He will say to you, "Boss, you were never unkind,
But you've given me stuff
Not adhesive enough
Not refractory or tough, never likely to bind."

"You were never unkind"

If you'll take my advice (and you'll find that I'm right),
You will never use aught but that there "Pyrolyte",
Though it's dry as a bone
Water sets it like stone,
And it binds every brick unbelievably tight."

"If you'll take my advice"

Hard when cold, harder hot, it sets heat at defiance
Neither cracking nor fluxing, deserving reliance,
It has no bad points,
Never wears at the joints,
It's the last word in "Bonds" yet discovered by Science.
- Poetaster



"That there Pyrolyte"

ADDRESS BCM/PYROLYTE, LONDON W.1 ENQUIRIES

SOLE MAKERS THE GENERAL REFRACTORIES CO. LTD., SHEFFIELD

"PYROLYTE" THE COLD SETTING CEMENT

TITANIC IN ITS STRENGTH—UNMELTABLE

A sample 1 cwt. drum at 30/- delivered may be returned Carriage Forward if not approved.

IRON AND STEEL MARKETS.

Pig-Iron.

MIDDLESBROUGH.—Business on the Cleveland iron market continues to be extremely difficult. There is not enough pig-iron to go round, with the result that prompt supplies are exceedingly scarce, and makers are only very slowly implementing contracts in hand, a number of which date from before the strike. There is, in consequence, very little disposition to negotiate forward business, as users can in the circumstances afford to wait in the hope of easier terms. Prices have been very firm, but for this month there will be a concession of half-a-crown a ton. Apart from that, however, there would seem but little likelihood of further reductions in price for some months to come, for it will be some time before supply can overtake demand. The steelworks continue to take the bulk of the iron produced, and their commitments are such that there is little hope of any early diminution in their requirements. The number of furnaces now in blast on the North-East Coast is 44, and it is gradually increasing. But it will probably be a long time before the average of normal trade years, which was something over 70, can be reached.

The scarcity of hematite on the East Coast is very pronounced, and the price of East Coast mixed numbers remains firm and unchanged at 90s. per ton. Export business could be done at this figure, but it is next to impossible to obtain supplies, and boats are having to go away without material. On the West Coast business has taken a quieter turn in the hematite pig-iron trade. The first rush of orders is over, and users who have contracted for their requirements for the next three or four months are exhibiting little anxiety yet as to the satisfaction of the needs that may arise towards the end of the half-year. The advance in prices has checked the impulse to enter into further commitments, and there is a disposition still to await developments, if only in the hope that fuel costs may be lowered to enable makers to quote easier terms. Smelters meantime hold a strong position, inasmuch as they are well sold forward, and are still picking up a little useful business that delays the day when they might have to restrict their output.

LANCASHIRE.—Apart from the fact that the supply position in regard to pig-iron is becoming easier, there has been little in the way of development on the Lancashire pig-iron market during the past week. One of the largest producers of Derbyshire iron states that within the next week or two specifications against contracts will have been overtaken, and that by that time the position will not be far removed from normal. So far as the placing of new business is concerned, users are doing no more than is absolutely necessary to provide for their early needs, with the consequence that current transactions are limited in number and of no great aggregate weight. Most kinds of pig-iron are in the neighbourhood of 17s. 6d. per ton higher than they were before the coal stoppage, and it is not unlikely that a lower level of quotations would stimulate the market.

Metals.

Copper.—Developments in the copper market have fallen short of recent optimistic expectations, although it is understood that something like 20,000 tons of fine copper were disposed of by American producers. But for the control exercised by the export combine, there is little doubt that the larger merchant interests would have placed important orders with producers. Standard copper has been again reactionary, although showing a little rally at one time. Manufactured copper has been a little more active, but irregular, and export business remains restricted, with India a rather poor buyer. There is some uncertainty as to prospects, but it is not improbable that the market will show a little more stability, while it is considered that the American statistics for December were already discounted.

Official closing prices of standard copper have been as follow :—

Cash : Thursday, £54 15s. to £54 17s. 6d. ; Friday, £54 12s. 6d. to £54 15s. ; Monday, £54 8s. 9d. to £54 11s. 3d. ; Tuesday, £54 10s. to £54 12s. 6d. ; Wednesday, £54 5s. to £54 7s. 6d.

Three Months : Thursday, £55 7s. 6d. to £55 10s. ; Friday, £55 5s. to £55 7s. 6d. ; Monday, £55 to £55 2s. 6d. ; Tuesday, £55 to £55 2s. 6d. ; Wednesday, £54 15s. to £55 17s. 6d.

Tin.—Standard cash tin has become exceedingly irregular, the price coming down to the lowest since August 24 last. The reactionary feeling ensued under continued weaker surroundings, and trade buying has remained restricted. There is, however, a fairly confident feeling as to developments in the near future, this being chiefly based on the strong statistical position, with no indication of any increased supplies for some time to come. In fact, sentiment continues to be influenced by a certain set-back in the Straits output, owing to the recent floods. The Straits shipments this month are not expected to be in excess of 6,000 tons, and, allowing for reduced contributions from Dutch sources, it is very probable that the visible supply will experience a shrinkage of over 1,000 tons. American deliveries for January are estimated at about 7,000 tons, which would be well in excess of the monthly average for the past year. The British stocks have only slightly increased.

Official closing prices of standard tin have been as under :—

Cash : Thursday, £290 15s. to £291 ; Friday, £287 5s. to £287 15s. ; Monday, £292 to £292 5s. ; Tuesday, £295 15s. to £296 ; Wednesday, £297 15s. to £298.

Three Months : Thursday, £286 10s. to £286 15s. ; Friday, £283 10s. to £283 15s. ; Monday, £286 15s. to £287 ; Tuesday, £290 to £290 5s. ; Wednesday, £291 10s. to £291 15s.

Spelter.—The market for ordinary brands of spelter is easier on a cautious demand and liberal offers. The metal has also been affected by poor American statistics and lack of support in this market, but the undertone has not really been bad at the reduced level of values. Belgian production continues to expand in common with the tendency in most producing directions.

The following are the week's prices :—

Ordinary : Thursday, £29 8s. 9d. ; Friday, £29 5s. ; Monday, £29 5s. ; Tuesday, £29 13s. 9d. ; Wednesday, £29 7s. 6d.

Lead.—Soft foreign lead is decidedly weaker, and at the moment confidence is naturally somewhat lacking. Until consumers re-enter the market a dull tone must prevail. Unfortunately, consumption has not yet been stimulated by the heavy fall, and confidence has waned, as arrivals continue to be heavy and stocks accumulate. The recent improvement in demand from the Continent was not carried very far, and shows no sign at the moment of recurring.

The week's prices are appended :—

Soft foreign (prompt) : Thursday, £25 17s. 6d. ; Friday, £26 16s. 3d. ; Monday, £26 10s. ; Tuesday, £26 17s. 6d. ; Wednesday, £26 10s.

PHONE: CITY 8374. GRAMS: "RESERVIST, MANCHESTER."
GRANDIDGE & MANSERGH
LIMITED.
MINERAL and VEGETABLE
BLACKINGS
FOR ALL CLASSES OF FOUNDRY WORK.
WRITE FOR COMPLETE STOCK LIST "F."
Wheathill St. Works, SALFORD,
ESTABLISHED OVER A CENTURY. LANCS.

SANKEY
Pressed Steel
FOUNDRY
LADLES

Sankeys are equipped to supply every type of foundry ladle, plain or lipped, with the utmost speed and efficiency. When you want good ladles at a fair price, write to Sankeys.
JOSEPH SANKEY & SONS LTD.
Hadley Castle Works,
Wellington - - - Shropshire.